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Description

Technical Field of the Invention

5 [0001] The present invention relates to coated hard alloy blade members or cutting tools having exceptional steel and cast iron cutting ability for both continuous and interrupted cutting.

Background Art

[0002] Until now, the use of a coated cemented carbide cutting tool made by using either chemical vapor deposition or physical vapor deposition to apply a coating layer of an average thickness of 0.5-20 µm comprised of either multiple layers or a single layer of one or more of titanium carbide, titanium nitride, titanium carbonitride, titanium oxycarbide titanium oxycarbonitride, and aluminum oxide (hereafter indicated by TiC, TiN, TiCN, TiCN, TiCNO, and Al₂O₃) onto a WC-based cemented carbide substrate for cutting steel or cast iron has been widely recognized.

[0003] The most important technological advance that led to the wide usage of the above-mentioned coated cemented carbide cutting tool was, as described in Japanese Patent Application No. 52-46347 (JP-A-53-131 909) and Japanese Patent Application No. 51-27171 (JP-A-52-110 209), the development of an exceptionally tough substrate wherein the surface layer of a WC-based cemented carbide substrate included a lot of Co, a binder metal, in comparison with the interior, whereby the fracture resistance of the coated cemented carbide cutting tool rapidly improved.

[0004] In addition, as disclosed in Japanese Patent Application No. 52-156303 (JP-A-54-87 719) and Japanese Patent Application No. 54-83745 (JP-A-56-009 365), the confirmation that, by sintering the WC-based cemented carbide containing nitrogen in a denitrifying atmosphere such as a vacuum, the surface layer of the WC-based cemented carbide substrate can be made from WC-Co which does not include a hard dispersed phase having a B-1 type crystal structure, whereby it is possible to cheaply produce WC-based cemented carbide having more Co in its surface layer than in the interior, was also important.

[0005] Concerning the advancement of the coating layer, coated cemented carbides having coating layers wherein the X-ray diffraction peaks of the Ti compounds such as TiC, TiN, and TiCN have a strong (200) orientation and the Al_2O_3 has an α -type crystal structure such as described in Japanese Patent Application No. 61-231416 (JP-A-63-089 202) and coated cemented carbides having coating layers wherein the X-ray diffraction peaks of the Ti compounds such as TiC, TiN, and TiCN have a strong (220) orientation and the Al_2O_3 has a κ -type crystal structure such as described in Japanese Patent Application No. 62-29268 (JP-A-63-195 268) have little variation in the tool life.

[0006] Furthermore, Japanese Patent Application No. 2-156663 (JP-B-7-88 582) shows that a coated cemented carbide having a coating layer wherein the TiC has a strong (111) orientation and the Al_2O_3 is of the κ -type has the features that there is less spalling of the coating layer and has a long life.

[0007] However, since the Ti compounds such as TiC of Japanese Patent Application No. 61-231416, Japanese Patent Application No. 62-29268, and Japanese Patent Application No. 2-156663 are coated by the normal CVD method, the crystal structure is in a granular form identical to the coating layers of the past, and the cutting ability was not always satisfactory.

[0008] Additionally, Japanese Patent Application No. 50-16171 (corresponding to GB-A-1 489 102) discloses that coating is possible with the use of organic gas for a portion of the reaction gas, at a relatively low temperature. In this patent, the crystal structure of the coating layer is not described, and furthermore, the crystal structure may have a granular form, or the crystals may grow in one direction (elongated crystals) depending on the coating conditions. Moreover, in the references given in this patent, the coating layer is made up of only TiCN, and Al₂O₃ is not disclosed. Additionally, this TiCN had a low bonding strength with the substrate.

SUMMARY OF THE INVENTION

[0009] In recent years cutting technology has shown remarkable progress towards unmanned, high speed processes. Therefore, tools which are highly resistant to wear and fracturing are required. Consequently, the present inventors conducted research to develop a coated cemented carbide cutting tool having cutting ability of a higher level.

[0010] It was discovered that by coating the surface of a WC-based cemented carbide substrate and a TiCN-based cermet substrate with TiCN having crystals growing in one direction (elongated crystals) as an inner layer, and coating with Al_2O_3 having a crystal structure κ or κ + α wherein κ > α as an outer layer, remarkable steel and cast iron cutting ability was shown for both continuous cutting and interrupted cutting.

[0011] Thus, the coated hard alloy blade member as described in claim 1, in accordance with the present invention comprises a substrate formed of a hard alloy selected from the group consisting of a WC-based cemented carbide and a TiCN-based cermet, and a hard coating deposited on said substrate, the hard coating including an inner layer of TiCN having unilaterally grown crystals of an elongated shape and an outer layer of Al $_2$ O $_3$ having a crystal form κ or κ + α

wherein $\kappa > \alpha$.

BRIEF DESCRIPTION OF THE DRAWING

5 [0012]

FIG. 1 is a photograph of a coated cemented carbide blade member in accordance with the present invention as taken by a scanning electron microscope.

10 DETAILED DESCRIPTION OF THE INVENTION

[0013] The coated hard alloy blade member or cutting tool in accordance with the present invention will now be described in detail.

[0014] As mentioned before, the coated hard alloy blade member in accordance with the present invention comprises a substrate formed of a hard alloy selected from the group consisting of a WC-based cemented carbide and a TiCN-based cermet, and a hard coating deposited on said substrate, the hard coating including an inner layer of TiCN having unilaterally grown crystals of an elongated shape and an outer layer of Al_2O_3 having a crystal form κ or κ + α wherein κ > α .

[0015] In order to practicalize the present invention, it is first necessary to coat the substrate with elongated crystal TiCN having high bonding strength. If the conditions are such that, for example, during the coating of the TiCN, the percentages of the respective volumes are: TiCl4: 1-10%, CH₃CN: 0.1-5%, N₂: 0-35%, H₂: the rest, the reaction temperature is 800-950 °C, the pressure is 30-500 Torr, and furthermore, the CH₃CN gas is decreased to 0.01-0.1% at the beginning of the coating as a first coating reaction for 1-120 minutes, then the CH₃CN gas is increased to 0.1-1% as a second coating reaction, then elongated crystal TiCN having high bonding strength can be obtained. The thickness of the TiCN coating layer should preferably be 1-20 μm. This is because at less than 1 μm the wear resistance worsens, and at more than 20 μm the fracture resistance worsens.

[0016] Furthermore, during the coating of the TiCN, if the reaction temperature or the amount of CH_3CN is increased, the (200) plane component of the X-ray diffraction pattern of the TiCN becomes weaker than the (111) and (220) plane components, the bonding strength with the Al_2O_3 in the upper layer which has κ as its main form increases, and the wear resistance goes up.

[0017] Next, Al_2O_3 of κ form or κ + α form wherein form κ > α is coated. For coating Al_2O_3 which has κ as its principal form, the conditions should be such that, for example, the reaction gas is made up of the following volume percentages in the first 1-120 minutes: $AlCl_3$: 1-20%, HCl: 1-20% and/or H_2S : 0.05-5% as needed, and H_2 : the rest, and a first reaction be performed, then afterwards, a second reaction is performed in which $AlCl_3$: 1-20%, CO_2 : 0.5-30%, HCl: 1-20% and/or H_2S : 0.05-5% as needed, and H_2 : the rest, with the conditions of a reaction temperature of 850-1000 °C and pressure of 30-500 Torr.

[0018] The thickness of this Al_2O_3 coating layer should preferably be 0.1-10 μ m. At less than 0.1 μ m the wear resistance worsens, while at over 10 μ m the fracturing resistance worsens.

[0019] The combined thickness of the first TiCN layer and the second Al_2O_3 layer should preferably be 2-30 μ m.

[0020] The K ratio of the $\kappa + \alpha$ Al₂O₃ of the present invention uses a peak from Cu- $\kappa\alpha$ X-ray diffraction, and is determined the following equation, wherein if $\kappa > \alpha$ then the κ ratio is over 50%.

$$I_{\kappa 2.79} + I_{\kappa 1.43}$$

 $\kappa \text{ ratio (\%)} = ---- \times 100$
 $I_{\kappa 2.79} + I_{\kappa 1.43} + I_{\alpha 2.085} + I_{\alpha 1.601}$

50 wherein

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 $I_{\kappa2.79}$: The height of the X-ray diffraction peak for ASTM No. 4-0878 with a plane index spacing of d = 2.79 The height of the X-ray diffraction peak for ASTM No. 4-0878 with a plane index spacing of d = 1.43 The height of the X-ray diffraction peak for ASTM No. 10-173 with a plane index spacing of d = 2.085 (the (113) plane)

 $I_{\alpha 1.601}$: The height of the X-ray diffraction peak for ASTM No. 10-173 with a plane index spacing of d = 1.601 (the (116) plane)

[0021] As further modified embodiments of the present invention, the following are included.

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- (1) As an outermost layer, either one or both of TiN or TiCN may be coated on the outer Al_2O_3 layer. The reason for this coating layer is to discriminate between areas of use, and a thickness of 0.1-2 μ m is preferable.
- (2) As an innermost layer, either one or more of TiN, TiC, or TiCN (granular form) may be coated underneath the inner TiCN layer. By coating with this innermost layer, the bonding strength of the elongated crystal TiCN improves and the wear resistance improves. The most preferable thickness for this coating is 0.1-5 µm.
- (3) Between the inner TiCN layer and the outer Al₂O₃ layer, either one or more of TiN, TiC, or TiCN (granular form) may be coated as a first intermediate layer. This first intermediate layer improves the wear resistance during low speed cutting. However, during high speed cutting, it worsens the wear resistance. The most preferable thickness for this first intermediate layer is 1-7 µm.
- (4) Between the inner TiCN layer and the outer Al_2O_3 layer, either one or both of TiCO, TiCNO is coated as a second intermediate layer. This second intermediate layer increases the bonding strength between the elongated crystal TiCN and the κ or $\kappa + \alpha$ form Al_2O_3 . The most preferable thickness of this second intermediate layer is 0.1-2 μ m. (5) It is possible to combine the above-mentioned (1)-(4) as appropriate.
- (6) The inner layer coated with elongated crystal TiCN may be divided by one or more TiN layers to define a divided TiCN layer. This divided TiCN layer is less susceptible to chipping, and the fracture resistance improves.
- (7) With the divided elongated TiCN described above and the κ or $\kappa + \alpha$ form Al₂O₃, it is possible to coat with an outermost layer of one or both of TiN or TiCN as in (1) above, coat with an innermost layer of one or more of TiN, TiC, or TiCN as in (2) above, coat with a first intermediate layer of one or more of TiC, TiN, or TiCN as in (3) above, coat with a second intermediate layer of one or both of TiCO or TiCNO as in (4) above, or to take a combination of them.
- (8) The most preferable composition of the WC-based cemented carbide substrate is, by the percentage of weight, as follows:

	Co: 4-12%	Ti: 0-7%	Ta: 0-7%
ļ	Nb: 0-4%	Cr: 0-2%	•
1	N: 0-1%	W and C: the rest	

Unavoidable impurities such as O, Fe, Ni, and Mo are also included.

(9) For the WC-based cemented carbide of the present invention, for lathe turning of steel, it is preferable that the cemented carbide be such that the amount of Co or Co + Cr in the surface portion (the highest value from the surface to within 100 μ m) be 1.5 to 5 times the amount in the interior (1 mm from the surface), and for lathe turning of cast iron, it is preferable that there is no enrichment of the Co or Co + Cr, and that the amount of Co or Co + Cr be small. Furthermore, in the case of steel milling, cemented carbide in which there has been no enrichment of the Co or Co + Cr, and the amount of Co or Co + Cr is large, is preferable.

(10) The most preferable composition of the TiCN-based cermet substrate is, by the percentage of weight, as follows:

Co: 2-14%	Ni: 2-12%	Ta: 2-20%
Nb: 0.1-10%	W: 5-30%	Mo: 5-20%
N: 2-8%	Ti and C: the rest	
Cr, V, Zr, Hf: 0-5%		

Unavoidable impurities such as O and Fe are included.

(11) In the TiCN-based cermet of the present invention, the substrate surface layer (the largest value within 100 μ m of the surface) should be 5% or more harder than the interior (1 mm from the surface) or there should be no difference between the hardnesses of the surface layer and the interior.

[0022] The present invention will be explained in more detail by way of the following examples.

EXAMPLE 1

[0023] As the raw materials, medium grain WC powder having an average particle size of 3 μ m, 5 μ m coarse grain WC powder, 1.5 μ m (Ti, W)C (by weight ratio, TiC/WC = 30/70) powder 1.2 μ m (Ti, W)(C, N) (TiC/TiN/WC = 24/20/56) powder, 1.5 μ m Ti(C, N) (TiC/TiN = 50/50) powder, 1.6 μ m (Ta, Nb)C (TaC/NbC=90/10) powder, 1.8 μ m TaC powder, 1.1 μ m Mo₂C powder, 1.7 μ m ZrC powder, 1.8 μ m Cr₃C₂ powder, 2.0 μ m Ni powder, 2.2 μ m NiAl (Al: 31% by weight) powder, and 1.2 μ m Co powder were prepared, then these raw material powders were blended in the compositions shown in Table 1 and wet-mixed in a ball mill for 72 hours. After drying, they were press-shaped into green compacts of the form of ISO CNMG 120408 (cemented carbide substrates A-D, cermet substrates F-G) and SEEN 42 AFTN 1 (cemented carbide substrates E and E'), then these green compacts were sintered under the conditions described in Table 1, thus resulting in the production of cemented carbide substrates A-E, E' and cermet substrates F-G.

[0024] Experimental values taken at over 1 mm from the surface of the sintered compacts of the cemented carbide substrates A-E, E' and the cermet substrates F-G are as shown in Table 2.

[0025] Furthermore, in the case of the above cemented carbide substrate B, after maintenance in an atmosphere of CH₄ gas at 100 torr and a temperature of 1400 °C for 1 hour, a gradually cooling carburizing procedure was run, then, by removing the carbon and Co attached to the substrate surface using acid and barrel polishing, a Co-rich region 40 μ m deep was formed in the substrate surface layer wherein, at a position 10 μ m from the surface the maximum Co content was 15% by weight.

[0026] Additionally, in the case of cemented carbide substrates A and D above, while sintered, a Co-rich region 20 µm deep was formed wherein, at a position 15 µm from the surface, the maximum Co content was 11% and 9% by weight, respectively, and in the remaining cemented carbide substrates C, E and E', no Co-rich region was formed, and they had similar compositions over their entirety.

[0027] In the above cermet substrates F and G, in the sintered state, a surface layer harder than the interior existed. The hardnesses at the surface and 1 mm below the surface for the cermet substrates F and G are shown in Table 2.

[0028] Next, after honing the surfaces of the cemented carbide substrates A-E, E' and cermet substrates F and G, by forming coating layers under the special coating conditions shown in Tables 3(a) and 3(b) and having the compositions, crystal structures, orientation of TiCN (shown, starting from the left, in the order of the intensity of the corresponding X-ray diffraction peak) and average thicknesses shown in Table 4 by using a chemical vapor deposition apparatus, the coated cemented carbide cutting tools of the present invention 1-12 and 15-26, the coated cermet cutting tools of the present invention 13, 14, 27, and 28, the coated cermeted carbide cutting tools of the prior art 1-12 and 15-26, and the coated cermet cutting tools 13, 14, 27, and 28 of the prior art were produced.

[0029] Then, for the coated cemented carbide cutting tools of the present invention 1-10 and 15-24, and the coated cemented carbide cutting tools of the prior art 1-10 and 15-24, a mild steel continuous cutting test was performed under the following conditions,

Workpiece: mild steel round bar Cutting Speed: 270 m/min Feed: 0.25 mm/rev Depth of Cut: 2 mm Cutting Time: 30 min

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in which a determination was made whether or not the cutting failed due to tears made in the workpiece because of chipping of the cutting blade or spalling of the coating layer. Then, for those which were able to cut for the set period of time, the amount of flank wear was measured. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove Cutting Speed: 250 m/min Feed: 0.25 mm/rev

Depth of Cut: 1.5 mm Cutting Time: 40 min

in which a determination was made whether or not the cutting failed due to trouble such as fracturing or chipping of the cutting blade. Then, for those which were able to cut for the set period of time, the amount of flank wear was measured. [0030] For the coated cemented carbide cutting tools of the present invention 11, 12, 25 and 26, and the coated cemented carbide cutting tools of the prior art 11, 12, 25 and 26, a mild steel milling test was performed under the following conditions,

Workpiece: mild steel square block;

Cutting Speed: 250 m/min Feed: 0.35 mm/tooth Depth of Cut: 2.5 mm Cutting Time: 40 min

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in which a determination was made whether or not the milling failed due to trouble such as chipping of the cutting blade. Then, for those which were able to cut for the set period of time, the amount of flank wear was measured.

[0031] For the coated cermet cutting tools of the present invention 13, 14, 27 and 28, and the coated cermet cutting tools of the prior art 13, 14, 27 and 28, a mild steel continuous cutting test was performed under the following conditions,

Workpiece: mild steel round bar Cutting Speed: 320 m/min Feed: 0.25 mm/rev Depth of Cut: 1 mm

Cutting Time: 20 min

in which a determination was made whether or not the cutting failed due to chipping or fracturing of the cutting blade.

Then, for those which were able to cut for the set period of time, the amount of flank wear was measured. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove

Cutting Speed: 300 m/min Feed: 0.20 mm/rev Depth of Cut: 1 mm Cutting Time: 20 min

in which a determination was made whether or not the cutting failed due to trouble such as chipping of the cutting blade. Then, for those which were able to cut for the set period of time, the amount of flank wear was measured.

[0032] The results of the above tests are shown in Tables 4-7. As is able to be seen from Tables 4-7, all of the coated cemented carbide cutting tools and coated cermet cutting tools of the present invention demonstrate the properties that it is difficult to fracture or chip the cutting blades and spalling of the coating layers is rare, in addition to exhibiting superior wear and fracture resistance.

35 EXAMPLE 2

[0033] Using the same cemented carbide substrates A-E, E' and cermet substrates F and G as Example 1, under the same coating conditions as shown in Tables 3(a) and 3(b) in Example 1, by forming coating layers of the composition, crystal structures, and average thicknesses shown in Tables 8 and 9, the coated cemented carbide cutting tools of the present invention 29-40, the coated cermet cutting tools of the present invention 41 and 42, the coated cemented carbide cutting tools of the prior art 29-40, and the coated cermet cutting tools 41 and 42 of the prior art were produced.

[0034] Then, for the coated cemented carbide cutting tools of the present invention 29-38, and the coated cemented carbide cutting tools of the prior art 29-38, a mild steel continuous cutting test was performed under the following conditions,

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Workpiece: mild steel round bar Cutting Speed: 250 m/min Feed: 0.27 mm/rev Depth of Cut: 2 mm Cutting Time: 30 min

and an appraisal identical to that of Example 1 was made. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove

Cutting Speed: 230 m/min Feed: 0.27 mm/rev Depth of Cut: 1.5 mm

Cutting Time: 40 min

and an appraisal identical to that of Example 1 was made.

[0035] For the coated cemented carbide cutting tools of the present invention 39 and 40, and the coated cemented carbide cutting tools of the prior art 39 and 40, a mild steel milling test was performed under the following conditions,

Workpiece: mild steel square block

Cutting Speed: 230 m/min Feed: 0.37 mm/tooth Depth of Cut: 2.5 mm Cutting Time: 40 min

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and an appraisal identical to that of Example 1 was made.

[0036] For the coated cermet cutting tools of the present invention 41 and 42, and the coated cermet cutting tools of the prior art 41 and 42, a mild steel continuous cutting test was performed under the following conditions,

Workpiece: mild steel round bar Cutting Speed: 300 m/min Feed: 0.27 mm/rev Depth of Cut: 1 mm Cutting Time: 20 min

and an appraisal identical to that of Example 1 was made. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove

Cutting Speed: 280 m/min Feed: 0.22 mm/rev Depth of Cut: 1 mm Cutting Time: 20 min

and an appraisal identical to that of Example 1 was made.

[0037] The results of the above tests are shown in Tables 8, 9(a) and 9(b). As is able to be seen from Tables 8, 9(a) and 9(b), all of the coated cemented carbide cutting tools and coated cermet cutting tools of the present invention demonstrate the properties that it is difficult to fracture or chip the cutting blades and spalling of the coating layers is rare, in addition to exhibiting superior wear and fracture resistance.

EXAMPLE 3

[0038] Using the same cemented carbide substrates A-E, E' and cermet substrates F and G as Example 1, under the same coating conditions as shown in Tables 3(a) and 3(b) in Example 1, by forming coating layers of the composition, crystal structures, and average thickness shown in Tables 10-13, the coated cemented carbide cutting tools of the present invention 43-54 and 57-68, the coated cermet cutting tools of the present invention 55,56, 69 and 70, the coated cemented carbide cutting tools of the prior art 43-54 and 57-68, and the coated cermet cutting tools 55, 56, 69 and 70 of the prior art were produced. Figure 1 shows a photograph of the surface layer of the coated cemented carbide cutting tool of the present invention as taken by a scanning electron microscope.

[0039] Then, for the coated cemented carbide cutting tools of the present invention 43-52 and 57-66, and the coated cemented carbide cutting tools of the prior art 43-52 and 57-66, a mild steel continuous cutting test was performed under the following conditions.

Workpiece: mild steel round bar Cutting Speed: 280 m/min Feed: 0.23 mm/rev Depth of Cut: 2 mm

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and an appraisal identical to that of Example 1 was made. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove

Cutting Speed: 260 m/min Feed: 0.23 mm/rev Depth of Cut: 1.5 mm Cutting Time: 40 min

and an appraisal identical to that of Example 1 was made.

[0040] For the coated cemented carbide cutting tools of the present invention 53, 54, 67 and 68, and the coated cemented carbide cutting tools of the prior art 53, 54, 67 and 68, a mild steel milling test was performed under the following conditions,

Workpiece: mild steel square block

Cutting Speed: 260 m/min Feed: 0.33 mm/tooth Depth of Cut: 2.5 mm Cutting Time: 40 min

and an appraisal identical to that of Example 1 was made.

[0041] For the coated cermet cutting tools of the present invention 55, 56, 69 and 70, and the coated cermet cutting tools of the prior art 55, 56, 69 and 70, a mild steel continuous cutting test was performed under the following conditions,

Workpiece: mild steel round bar Cutting Speed: 330 m/min Feed: 0.23 mm/rev Depth of Cut: 1 mm

Cutting Time: 20 min

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and an appraisal identical to that of Example 1 was made. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove

Cutting Speed: 310 m/min Feed: 0.18 mm/rev Depth of Cut: 1 mm Cutting Time: 20 min

and an appraisal identical to that of Example 1 was made.

[0042] The results of the above tests are shown in Tables 10-13. As is able to be seen from Tables 10-13, all of the coated cemented carbide cutting tools and coated cermet cutting tools of the present invention demonstrate the properties that it is difficult to fracture or chip the cutting blades and spalling of the coating layers is rare, in addition to exhibiting superior wear and fracture resistance.

EXAMPLE 4

[0043] Using the same cemented carbide substrates A-E, E' and cermet substrates F and G as Example 1, under the same coating conditions as shown in Tables 3(a) and 3(b) in Example 1, by forming coating layers of the composition, crystal structures, and average thicknesses shown in Tables 14-17, the coated cemented carbide cutting tools of the present invention 71-82 and 85-96, the coated cermet cutting tools of the present invention 83, 84, 97 and 98, the coated cemented carbide cutting tools of the prior art 71-82 and 85-96, and the coated cermet cutting tools 83, 84, 97 and 98 of the prior art were produced.

[0044] Then, for the coated cemented carbide cutting tools of the present invention 71-80 and 85-94, and the coated cemented carbide cutting tools of the prior art 71-80 and 85-94, a mild steel continuous cutting test was performed under the following conditions,

Workpiece: mild steel round bar Cutting Speed: 260 m/min Feed: 0.26 mm/rev Depth of Cut: 2 mm

Cutting Time: 30 min

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and an appraisal identical to that of Example 1 was made. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove

Cutting Speed: 240 m/min Feed: 0.26 mm/rev Depth of Cut: 1.5 mm Cutting Time: 40 min

and an appraisal identical to that of Example 1 was made.

[0045] For the coated cemented carbide cutting tools of the present invention 81, 82, 95 and 96, and the coated cemented carbide cutting tools of the prior art 81, 82, 95 and 96, a mild steel milling test was performed under the following conditions,

Workpiece: mild steel square block

Cutting Speed: 240 m/min Feed: 0.36 mm/tooth Depth of Cut: 2.5 mm Cutting Time: 40 min

and an appraisal identical to that of Example 1 was made.

[0046] For the coated cermet cutting tools of the present invention 83, 84, 97 and 98, and the coated cermet cutting tools of the prior art 83, 84, 97 and 98, a mild steel continuous cutting test was performed under the following conditions,

Workpiece: mild steel round bar Cutting Speed: 310 m/min Feed: 0.26 mm/rev Depth of Cut: 1 mm Cutting Time: 20 min

and an appraisal identical to that of Example 1 was made. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove

Cutting Speed: 290 m/min Feed: 0.21 mm/rev Depth of Cut: 1 mm Cutting Time: 20 min

and an appraisal identical to that of Example 1 was made.

[0047] The results of the above tests are shown in Tables 14-17. As is able to be seen from Tables 14-17, all of the coated cemented carbide cutting tools and coated cermet cutting tools of the present invention demonstrate the properties that it is difficult to fracture or chip the cutting blades and spalling of the coating layers is rare, in addition to exhibiting superior wear and fracture resistance.

EXAMPLE 5

[0048] Using the same cemented carbide substrates A-E, E' and cermet substrates F and G as Example 1, under the same coating conditions as shown in Tables 3(a) and 3(b) in Example 1, by forming coating layers of the composition, crystal structures, and average thicknesses shown in Tables 18-21, the coated cemented carbide cutting tools of the present invention 99-112 and 122-126, the coated cermet cutting tools of the present invention 113-121, the coated cemented carbide cutting tools of the prior art 99-112 and 122-126, and the coated cermet cutting tools 113-121 of the prior art were produced.

[0049] Then, for the coated cemented carbide cutting tools of the present invention 99-112, and the coated cemented carbide cutting tools of the prior art 99-112, a mild steel high-feed continuous cutting test was performed under the following conditions,

Workpiece: mild steel round bar Cutting Speed: 210 m/min Feed: 0.38 mm/rev Depth of Cut: 2 mm

5 Cutting Time: 30 min

and an appraisal identical to that of Example 1 was made. Furthermore, a deep cut interrupted cutting test was performed under the following conditions,

10 Workpiece: mild steel round bar

Cutting Speed: 210 m/min Feed: 0.23 mm/rev Depth of Cut: 4 mm Cutting Time: 40 min

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and an appraisal identical to that of Example 1 was made.

[0050] For the coated cemented carbide cutting tools of the present invention 122-126, and the coated cemented carbide cutting tools of the prior art 122-126, a mild steel milling test was performed under the following conditions,

20 Workpiece: mild steel square block

Cutting Speed: 260 m/min Feed: 0.33 mm/tooth Depth of Cut: 3 mm Cutting Time: 40 min

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and an appraisal identical to that of Example 1 was made.

[0051] For the coated cermet cutting tools of the present invention 113-121, and the coated cermet cutting tools of the prior art 113-121, a mild steel continuous cutting test was performed under the following conditions,

30 Workpiece: mild steel round bar

Cutting Speed: 340 m/min Feed: 0.22 mm/rev Depth of Cut: 1 mm Cutting Time: 20 min

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and an appraisal identical to that of Example 1 was made. Furthermore, an interrupted cutting test was performed under the following conditions,

Workpiece: mild steel round bar with groove

Cutting Speed: 320 m/min Feed: 0.17 mm/rev

Depth of Cut: 1 mm Cutting Time: 20 min

and an appraisal identical to that of Example 1 was made.

[0052] The results of the above tests are shown in Tables 18-21. As is able to be seen from Tables 18-21, all of the coated cemented carbide cutting tools and coated cermet cutting tools of the present invention demonstrate the properties that it is difficult to fracture or chip the cutting blades and spalling of the coating layers is rare, in addition to exhibiting superior wear and fracture resistance.

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TABLE 1

Туре				Blend Compos	Blend Composition (% by weight)	eight)		Sin	Sintering Conditions	ons ·
		ပိ	(Ti, W)C	(Ti, W)CN	(Ta, Nb)C	Cr3C2	MC	Pressure	Temperature (°C)	Holding Time(hours)
	<	9		9	4	ı	Balance (medium grain)	Vacuum (0.10 torr)	1380	
	83	S	5		\$.	-	Balance (medium grain)	Vacuum (0.05 torr)	1450	1
Cemented Carbide Substrate	U	6	œ	,	5	-	Balance (medium grain)	Vacuum (0.05 torr)	1380	1.5
	٥	۶		\$.	٩	+	Balance (medium grain)	Vacuum (0.05 torr)	1410	1
:	гā	. 10		,	2	•	Balance (coarse grain)	Vacuum (0.05 torr)	1380	
	ъ	10		-	,	7.0	Balance (coarse grain)	Vacuum (0.05 torr)	1380	1
Cermet	L.	30.2 Tic	Tic - 23 TiN - - 0.3 NiAl	10 TaC - 13 4	Tic - 23 TiN - 10 TaC - 13 WC - 10 Mo ₂ C - 0.5 ZrC - 8 Co - 0.3 NiAl	- 0.5 ZrC	- 8 Co -	Vacuum (0.10 torr)	1500	1.5
Substrate	0	57 TICN	- 10 TaC - 1	NDC - 9 WC -	57 TiCN - 10 TaC - 1 NbC - 9 WC - 9 Mo2C - 7 Co - 7 Ni	Co - 7 Ni	·	N ₂ Atmosphere	1520	1.5

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TABLE 2

		(1) by weight	Нага	Hardness
		Composition of structure of the state of the	Interior (HRA)	Surface (HRA)
	<	6.1 Co - 2.1 Ti - 3.4 Ta - 0.4 Nb - Rest (W + C)	90.5	•
.1.	E	5.2 Co - 1.2 Ti - 4.2 Ta - 0.4 Nb - Rest (W + C)	91.0	ŧ
<u> </u>	U	9.0 Co - 1.9 Ti - 4.3 Ta - 0.4 Nb - Rest (W + C)	90.3	1
Cemented	۵	5.2 Co - 1.7 Ti - 2.5 Ta - 0.3 Nb - Rest (W + C)	91.1	1
Supstrate	ш	9.8 Co - 1.7 Ta - 0.2 Nb - Rest (W + C)	69.7	•
	in in	9.8 Co - 0.6 Cr - Rest (W + C)	89.8	
	(s.	9.4 Ta - 12.2 W - 9.4 MO - 0.4 Zr - 7.9 Co - 5.1 Ni - 0.1 Al - 3.8 N -	91.7	92.2
Substrate	U	1 4	91.6	92.6

TABLE 3 (a)

[Coating Conditions]

_	(coating cond.	,			
5	Composition	X-ray Orientation	Gas Composition (% by volume)	Temperature (°C)	Pressure (Torr)
10	Innermost Layer Granular TiC		TiCl ₄ :2, CH ₄ :5, H ₂ :Rest	1020	50
	Innermost Layer Granular TiN		TiCl ₄ :2, N ₂ :25, H ₂ :Rest	920	50
15	Innermost Layer Granular TiCN		TiCl ₄ :2, CH ₄ :4, N ₂ :20, H ₂ :Rest	1020	50
	Inner Layer Elongaced TiCN	(111) (220) (200)	First Reaction - TiCl ₄ :2, CH ₃ CN:0.05, N ₂ :20, H ₂ :Rest Second Reaction - TiCl ₄ :2, CH ₃ CN:0.6, N ₂ :20, H ₂ :Rest	860	50
20	Inner Layer Elongated TiCN	(220) (111) (200)	First Reaction - TiCl ₄ :2. CH ₃ CN:0.05, N ₂ :20, H ₂ :Rest Second Reaction - TiCl ₄ :2, CH ₃ CN:0.6, N ₂ :20, H ₂ :Rest	900	50
	Inner Layer Elongated TiCN	(111) (200) (220)	First Reaction - TiCl ₄ :2. CH ₃ CN:0.05, N ₂ :20, H ₂ :Rest Second Reaction - TiCl ₄ :2. CH ₃ CN:0.3, N ₂ :20, H ₂ :Rest	860	50
25	Inner Layer Elongated TiCN	(220) (200) (111)	First Reaction - TiCl ₄ :4, CH ₃ CN:0.05, N ₂ :20, H ₂ :Rest Second Reaction - TiCl ₄ :4, CH ₃ CN:0.3, N ₂ :20, H ₂ :Rest	900	50
30	Inner Layer Granular TiCN	(111) (200) (220)	TiCl ₄ :4, CH ₄ :6, N ₂ :2, H ₂ :Rest	1050	500
	Inner Layer Granular TiCN	(220) (200) (111)	TiCl ₄ :4, CH ₄ :4, N ₂ :2, H ₂ :Rest	1050	500
-	Inner Layer Granular TiCN	(200) (220) (111)	TiCl ₄ :4, CH ₄ :2, N ₂ :2, H ₂ :Rest	1000	100
35	Divided Layer Granular TiN		TiCl ₄ :2, N ₂ :25, H ₂ :Rest	900	200
	Divided Layer Granular TiN		TiCl ₄ :2, N ₂ :25, H ₂ :Rest	860	300
40	First Incermediate Layer		TiCl4:2, CH4:5, H2:Rest	. 1020	50
45	Granular Tic First Intermediate Layer Granular Tick		TiCl ₄ :2, CH ₄ :4, N ₂ :20, H ₂ :Resc	1020	50
	Second Intermediate Layer Granular TiCO		TiCl4:4. CO:6. H2:Rest	980	50
50	Second Intermediace Layer Granular TiCNO		TiCl ₄ :4. CH ₄ :2, N2:1.5, CO ₂ :0.5, H ₂ :Rest	1000	50

TABLE 3 (b)

5		
	Composition	X-ray Orientation
10	Outer Layer Al ₂ O ₃	100%K
	Outer Layer Al ₂ O ₃	94 % K
15	Outer Layer Al ₂ O ₃	858K
•	Outer Layer Al ₂ O ₃	73 % K
20	Outer Layer Al ₂ O ₃	628K
	Outer Layer Al ₂ O ₃	55 % %
25	Outer Layer Al ₂ O ₃	408K
20	Outer Layer Al ₂ O ₃	100%α
30	Outermost Layer Granular TiN	
	I Out avenue	i

Composition	X-ray Orientation	Gas Composition (% capacity)	Temperature	Pressure (Torr)
Outer Layer Al ₂ O ₃	100%×	First Reaction - AlCl3:3%. H2:Rest Second Reaction - AlCl3:3%. CO2:5%. H2S:0.3, H2:Rest	970	50
Outer Layer Al ₂ O ₃	94%K	First Reaction - AlCl ₃ :3%, H ₂ :Rest Second Reaction - AlCl ₃ :3%, CO ₂ :5%, H ₂ :Rest	970	50
Outer Layer Al ₂ O ₃	85%K	First Reaction - AlCl ₃ :3%, H ₂ :Rest Second Reaction - AlCl ₃ :3%, CO ₂ :6%, H ₂ S:0.2, H ₂ :Rest	980	50
Outer Layer Al ₂ O ₃	73 % K	First Reaction - AlCl ₃ :3%, H ₂ :Rest Second Reaction - AlCl ₃ :3%, CO ₂ :6%, H ₂ :Rest	980	50
Outer Layer Al ₂ O ₃	62%K	First Reaction - AlCl ₃ :3%, H ₂ :Rest Second Reaction - AlCl ₃ :3%, CO ₂ :7%, H ₂ S:0.2, H ₂ :Rest	990	. 50
Outer Layer Al ₂ O ₃	55%K	First Reaction - AlCl3:3%, H2:Rest Second Reaction - AlCl3:3%, CO2:8%, H2:Rest	1000	50
Outer Layer Al ₂ O ₃	40%K	First Reaction - AlClj:3%. H ₂ S:0.05, H ₂ :Rest Second Reaction - AlClj:3%, CO ₂ :9%, H ₂ S:0.1, H ₂ :Rest	1010	50
Outer Layer Al ₂ O ₃	100\$α	AlCl3:3%, CO2:10%, H2:Rest	1020	100
Outermost Layer Granular TiN		TiCl4:2, N2:30, H2:Rest	1020	200
Outermost Layer Granular TiN		TiCl4:2, CH4:4, N2:20, H2:Rest	1020	200

TABLE 4

					Hard C	Hard Coating Layer					7.7
É	-	Substrate		Inner Layer	ır	Outer Layer	Layer	Outermost Layer	Layer	(usu)	η(υ)
adkı		Symbol									10000
			Composition	Crystal	Orientation	Composition	Crystal	Composition	Crystal Structure	Continuous	uncerrupted Cutting
	_	4	TiCN(8.4)	Elongated	(111) (220) (200)	A1203 (2.2)	x:948	Tin(0.5)	Granular	0.17	0.26
	2	4	Tich(5.5)	Elongated	(220) (111) (200)	A1203 (6.2)	K:858			0.19	0.28
		4	TiCN(11.4)	Elongated	(111) (220) (200)	A1203(1.8)	K: 1004	TiCN- TiN(0.7)	Granular	0.19	0.31
	~	8	TiCN(8.2)	Elongated	(111) (200) (220)	A1203 (2.1)	K: 1008	TIN10.4)	Granulor	0.17	0.31
Coated	5	a	TICN(5.1)	Elongated	(111) (220) (200)	A1203 (5.2)	K:738			0.21	0.26
Cementing	9	U	TiCN(10.2)	Elongated	(220) (111) (200)	A1203(1.2)	K:558	TiN(0.3)	Granular	0.22	0.31
Carbide]-	O	TiCN(5.4)	Elongated	(220) (200) (111)	A1203(0.9)	K:628	TIN(0.6)	Granular	0.26	0.34
Cutting	00	Q	TiCN(6.4)	Elongated	(111) (220) (200)	A1203 (5.7)	X:738	TiN(0.2)	Granular	0.16	0.26
Tool	6	G	TiCN(3.7)	Elongated	(220) (1111) (200)	A1203(8.2)	K:621			0.17	0.30
of the	9.	Q	TiCN(7.9)	Elongated	(111) (220) (200)	A1203 (2.5)	K:1008			0.18	0.26
Invention	[=	tu	TICN (4.21	Elongated	(220) (1111) (200)	A1203(0.5)	K: 1008			0.17	(Milling)
	12	ເລ	TiCN14.01	Elongated	(111) (220) (200)	A1203(0.4)	K:948	Tin(0.3)	Granular	0.19	(Milling)
	=	:-	TiCN(4.6)	Elongated	(220) (1111) (200)	A1203 (0.4)	K: 1001	TiN(0.4)	Granular	0.16	0.29
	7	U	TiCN(3.2)	Elongated	(111) (220) (200)	A1203 (0.8)	K:948	TiN(0.2)	Granular	0.16	0.21

TABLE 5

					Hard C	Hard Coating Layer				Flank Wear	Wear
Type		Substrate		Inner Layer	35	Outer Layer	'pher	Outermost Layer	t Layer	(men)	u)
			Composition	Crystal	Orientation	Composition	Crystal Structure	Composition	Crystal Structure	Continuous	Interrupted
	-	<	TiCN(8.5)	Granular	(111) (200) (220)	A1203(2.0)	α:1001	TIN(0.5)	Granular	0.47 (Chipping)	0.60 (Chipping)
	2	<	TiCN(5.4)	Granular	(220) (200) (111)	A1203(6.0)	a: 100%	*		0.52 (Chipping)	0.56 (Chipping)
1.	<u></u>	4	TiCN(11.3)	Granular	(111) (200) (220)	A1203(1.9)	K: 401	TiCN- Tin(0.8)	Granular	0.52 (Chipping)	0.65 (Chipping)
	4	8	TiCN(8.1)	Granular	(200) (220) (111)	A1203(2.2)	a: 100%	TIN(0.3)	Granular	Pailure after 12.8 min. due to Layer Separation	Fallure after 7.5 min. due to Layer Separation
	'n	8	TiCN(4.9)	Granular	(111) (200) (220)	A1203 (5.2)	α: 100 %			Failure after 10.7 min. due to Layer Separation	Failure after 5.3 min. due to Layer Separation
Coated Cemented	۰ .	v	TiCN(10.3)	Granular	(220) (200) (111)	A1203 (1.1)	α: 100¢	Tin(0.4)	Granular	Failure after 5.6 min. due to Layer Separation	Failure after 0.8 min. due to Fracturing
Cutting Tools of Prior Art	_	U	Tich(5.5)	Granular	(200) (220) (1111)	A1203(1.11	K:408	TiN(0.5)	Granular	Pailure after 10.4 min. due to Layer Separation	Failure after 3.2 min. due to Fracturing
	60	G	TiCN(6.5)	Granular	(111) (200) (220)	A1203 (5.6)	α:100Λ	Tin(0.3)	Granular	Pailure after 17.1 min. due to Chipping	Failure aiter 7.9 min. due to Chipping
. •	6	٥	ricn().8)	Gramular	(220) (200) (111)	A1203(8.4)	K: 408			Failure after 15.4 min. due to Chipping	Failure after 5.2 min. due to Chipping
	. 0	C	TiCN(7.7)	Granular	(111) (200) (220)	A1203 (2.4)	a:1001			Failure after 13.6 min. due to Chipping	Failure after 7.0 min. due co Chipping
•	=	9	TiCN(4.1)	Granular	(220) (200) (111)	A1203 (0.6)	α:1000			Failure after 20.8 min. due ro Chipping (Milling)	.8 min. due ro
	12	is:	TiCN(3.9)	Granular	(111) (200) (220)	A1203 (0.3)	α:1001	TiN(0.2)	Granular	Pailure after 17.7 min. due to Layer Scparation (Milling)	7 min. due to
	2	L	TiCN(4.4)	Granular	(220) (200) (111)	A1203 (0.4)	a:1001	TiN(0.4)	Granular	Failure after 1.0 min. due to Chipping	Failure after 0.1 min. due to Fracturing
	22.	o	T1CH(3.3)	Granular	Granular (111) (200) (220)	A1203 (0.9)	a:1001	Tin(0.3)	Granular	Failure after 2.8 min. due to Chipping	Failure after 0.2 min. due to Fracturing

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TABLE 6

					-	Hard Coating Layer						
Туре	Substrate	Innerm	innermost Layer		Inner Layer	ayer	Oute	Outer Layer	Outerm	Outermost Layer	7 TE)	(מתם)
		Compo-	Crystal	Compo-	Crystal	Orientation	Compo-	Crystal	Compo- sition	Crystal Structure	Continuous Cutting	Interrupted Cutting
115	<	ZiF	Granular	TiCN	Elongated	(111) (220) (200)	A1203	K:941	TIN	Granular	0.13	0.15
<u> </u>	<	Tin	Granular	TiCN	Elongated	(220) (111) (200)	A1203	K:858			0.15	0.14
11	<	TiCN (0.8)	Granular	TiCN (11.2)	Elongated	(111) (220) (200)	A1203	K: 1008	TiCN-	Granular	0.18	0.20
18		TiC-	Granular	TiCN (8.3)	Elongated Growth	(111) (200) (220)	A1203	K: 1004	(0.8) Tin (0.5)	Granular	0.16	0.21
Coated 19	6	7.iv	Granular	TiCN (4.8)	Elongated	(111) (220) (200)	A1203	K:731			0.17	0.17
Carbide 20	U	TiN (0.1)	Granular	TiCN (10.2)	Elongated	(220) (111) (200)	A1203	x:558	TiN (0.3)	Granular	0.17	0.20
Tools of 21	U	11C	Granular	TiCN (5.5)	Elongated Growth	(220) (200) (111)	A1203	K:628	TiN (0.5)	Granular	0.20	0.22
Invention 22	a	1.1N (0.6)	Granular	TiCN (6.5)	Elongated Growth	(111) (220) (200)	A1203	K:734			0.13	0.16
<u> </u> 2	٥	TiN (1.2)	Granular	TiCN (3.9)	Elongated Growth	(220) (111) (200)	A1203	K: 621			0.16	0.19
2	۵	TiCN (0.6)	Granular	7 iCN	Elongated	(111) (220) (200)	A1203	K:1004			0.17	0.18
22	#	T.i.N	Cranular	7.iCN	Elongated Growth	(220) (111) (200)	A1203	K:1001			0.13	(Milling)
56	ເບ	TiN (0.3)	Granular	TiCN (3.5)	Elongated	(111) (220) (200)	A1203	K:948	Tin (0.3)	Granular	0.15	(Milling)
~	Ŀ	TiN (7.7)	Granular	TiCN (4.5)	Elonyated Growth	(220) (111) (200)	1203	K: 1001	TÅN (0.4)	Granular	0.15	0.28
28	U	Tin	Granular	TiCN (3.1)	Elongated Growth	(111) (220) (200)	A1203	K:941	Tin (0.2)	Granular	0.14	0.27

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TABLE 7 (a)

	Y				_			_	_				1		,						, 7		٠,	, ,			١
Wede	(u	Interrupted	0.53 (Chipping)	0.50 (Chipping)	0.58	(Chipping)	Failure after 8.1	min. due to	Layer Separation	Failure	atter 7.5 min. due to	Layer	Separation	Failure after 1.7	Fracturing	Failure	min. due co	Practuring	Failure	after 10.		Failure	airer 3.0	$\overline{}$	Failure		
Flank Wgor	(mm)	Continuous Cutting	0.39 (Chipping)	0.43	0.51	(Chipping)	Failure	min. due to	Layer	Failure	after 14.5 min. due to	Layer	Separation	Failure after 8.7	min. due to Layer Separation	Failure	min. due to	Layer Separation	Failure	after 20.2	Chipping	Failure	arcer 15.1	Chipping	Failure	min. due to	C 11 1 1 1 1 1 2
	Outermost Layer	Crystal Structure	Granular		Granular		Granular							Granular		Granular					_						
	Outermo	Compo- sition	7 i.v		-20,4	TiN (0.7)	Tin	; :						TiN (0.3)		Tin	6.9								_		_
	Outer Layer	Crystal	a: 1001	α:1004		K: 40%	α:100%			4:1001				α:1001		K: 401			α:1001			K: 401			α:1001		
	Outer	Compo-	A1203	A1203	(9)	(2.1)	A1203	6. =		A1201	(4.9)			A1203		A1203	(0.9)		A1703	(8.0)		A1203	(8.2)		A1203	(2.5)	
Hard Coating Layer	er	Orientation	(111) (200) (220)	(220) (200) (111)		(111) (200) (220)	(200) (220) (111)			(1111,200) (220)				(220) (200) (111)		(200) (220) (111)			(111) (200) (220)			(220) (200) (111)			(111) (200) (220)		
K	Inner Layer	Crystal	Granular	Granular	-+	Granular	Granular			10000				Granular		Granular	-		Granilar			Granular			Granuler		_
		Compo-	TiCN	1:0 1:0 1:0	(5.3)	TiCN (11.4)	Tich	(8.4)		10,10	(4.2)			TICN		TICN	(5.4)		20,4	(6.7)		r N	(3,8)		Z.	(7.6)	
	Innermost Layer	Crystal	Structure	Granular		Granular	Cranular				Granular			Granular		Granular				כנפנותופו		Granular			Cranilar		
	Innermo	- odwoo	Sition	(0.1) Nin	(0.5)	1 iCN	5,5	T.	(1.4)		Z : S			Tin		716	(6.5)			217	: :	2	1 5	: :	30.1	(0.5)	
	Substrate	Symbol	<	•		<	-	<u> </u>			øn .			U		,	 ,			Ω		,	Э.			5	
-		" .	- -	-		5	-			7	6.			ļ _ņ		.	;		1	55		7	~			7	_
	Tvoc			!_	_								Coated	Carbide	Cutting Tools of												_

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_	_						_		_		_	-1	_	_		_
	Flank Wear	(mm)	Copringua Interrupted	Cutting	Foilure after 26.7 min.	ping	3r 23.3 min.	due to Layer Separation	Failure	after 0.1	min. due to min. due to	Fracturing	Failure	after 0.2	min. due to min. due to	Fracturing
	Flank	5	Continuous	_	_	due to Chipping (Milling)	Failure after 23.3 min.	due to Layer	١		min. due to	Chipping		after 3.0	min. due to	Chipping
		Outermost Layer	10.000	Crystal Compo- Livstal Structure			Granular		Cranitar		_		Granular			
		Outerm		sition			27.6	(0.3)	i E	6.6		_	NIT	(0.3)	_	_
		Outer Layer			1_	nor: B		α:100%		α: 1001			1001	a: 100		
	L.	Oute		Compo-	١.	(0.6)		(0.4)	- 1		7.00	_		27.503	6.2	_
	Hard Coating Layer	yer		Orientation	111111111111111111111111111111111111111	(1111) (2007) (227)		(111) (200) (220)		(220) (200) (111)			10001100011111	(077) (007) (111)		
	₹	Inner Layer		ı	Scruccore	Granular		Granular		Granular				Granular		
			_	Compo-	۳ļ	11CN		71C		TiCN	4.4	_		TICN	(3.2)	
		Innermost Layer		Crystal	Structure	Granular		Granular		Granular				Granular		
		1		Compo-	sition	TiN (0.3)	_	TiN (0.3)	-	rin	(9.0)	_		Tin-	7iCN	10.13
		Cuberrato	Sumbol	100m/s	1	10)	_	 		6	_	_		U		
						25		92	_	22		_		82	_	_
		í	ad.(:					Coated	cemented	_		Tools of	Prior Are			_
	L_														_	

TABLE 7 (b)

ΔO

TABLE 8

						Hard Coating Layer	ing Layer						Flank Wear	Wear
1706	Sub-	Innermo	Innermost Layer		Inner Layer	ayer	Pli	Pirst	Outer Layer	Layer	Outermo	Outermost Layer	(HE)	
1	Symbol	,					Incera	Layer						1
		Compo- sition	Crystal Struc-	Compo- sition	Crystal Structure	Orientation	Compo- sition	Crystal Struc-	Compo- sition	Crystal Struc-	Compo- sition	Structure	nuous Cutting	rupted Cutting
29	<	Tin	Granular	Ticn	Elongated	(111) (220) (200)	Tic	Granular	A1203	K:941	Tin (0.2)	Granular	0.15	0.19
		. (6.9)		(6.5)	Growth	100271111710667	5 i	Granular	12.5	X:851			0.18	0.18
30	<	Nit C	Granular	1 i Cs	Elongated Growth	(007) (111) (077)	(2.4)		(6.9)					
15	<			TiCN (9.3)	Elongated Growth	(111) (220) (200)	TiC (2.3)	Granular	A1203	K: 1004	TiCN- TiN (0.8)	Granular	0.18	0.23
32	80	Tic-	Granular	Tich	Elongated	(111) (200) (220)	Tic	Granular	A1203	K:1001	TiN (0.2)	Granular	0.15	0.28
		Ni C		(4.5)	Growen				,,,,				91.0	0. 20
Coated 33	80	zit.	Granular	TiCN	Elongated	(111) (220) (200)	1ic (1.0)	Granular	A1203 (4.0)	к:738				
Carbide 34	U	Tiv	Granular	╀	Elongated	(220) (111) (200)	T1C	Granular	A1203	K: 551	7in (0.3)	Granular	0.19	0.24
Cutting Tools of 15	U	1.ic	Granular	4	Elongated	(220) (200) (111)	Tin	Granular	A1203	K: 621	Tin (0.3)	Granular	0.25	0.25
the Invention 36	٥	1.0. z	Granular	\bot	Elongated	(1111) (220) (200)	Tic (2 B)	Granular	A1203	K:731			0.15	0.30
16	0	(0.6)		TiCN	Elongated	(220) (111) (200)	r G	Granular	A1203	x:621			0.16	۲.21
38	c	TiCN	Granvlar	1.CN	Elongated	(111) (220) (200)	TiC (2.3)	Granular	A) 203	K: 1001			0.16	0.21
S.	E .	1.iv	Granular	 	Elongated	(220) (1111) (200)	Tic	Granular	A1203	K: 1001			0.15	(MC1:ingl
9	:a	.0.3		TiCN 5	Elongated	(111) (220) (200)	Tic (1.6)	Granular	11.20 20.50	K:941	TiN (0.2)	Granular	0.14	(Britting)
1.5			-	Ticn	Elongated	(220) (111) (200)	T1CN	Granular	A1203	K: 1001	TIN (0.2)	Granular	0.16	0.25
14	42 G	Tin-	Cranular	4	Elongated	(111) (220) (200)	Tic (1.0)	Granular	A1203 (0.6)	K: 941	TIN (0.3)	Granular	0.14	n.24

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TABLE 9 (a)

$\overline{}$																		_			_,					_	
Webr	Ē	Interrupted Cutting	0.54 (Chipping)	0.53 (Chipping)	0.48 (Chipping)	Failure after 8.8	min. due to Layer Separation	Failure	min. due to	Layer Separation	Failure	after 1.4	Fracturing	Failure	ofter 4.1	Min. due to		Failure	ofthe 9.3	min, due to	chipping	Foilure	Afte: 6.4	min due to	Calpring	after 8.2	min. due to Chipping
Flank Wear	(unu)	Continuous Cutting	0.43 (Chipping)	0.50 (Chipping)	0.50 (Chipping)	failure ofter 13.9	min. due to Layer Separation	Pailure afrar 11 1	min. due to	Layer Separation	Failure	after 6.8	Layer	Г		02 97	Separation	Failure	after 18.5	min. due to	Chipping	Failure	after 16.8	min. due to	Chipping		
	Outermost Layer	Crystal Struc- ture	Granular		Granular	Granular					Granular			Granular													
	Outerm	Compo- sition	TiN (0.2)		Ticn- Tin (0.6)	TIN (0.2)					TİN			Tin	(0.4)												
	Outer Layer	Crystal Struc- ture	α:1004	α:1001	K: 408	a:1001		a:100%			a:100%			K: 408				α · 1001				K: 401				α: 1001	
	Опсег	Compo- sition	A1203	A1203	A1203	A1203		A1203	(3.9)		A1203	(1.1)		A1203	10.0			11201	(4.8)			1303 م	(8.1)			1, 203	·
er	Pirst Intermediate Laver	Crystal Struc- ture	Granular	Granular	Granular	Granular		Granular		•	Gronular			Granular				Granular				Granular				Cranular	
ing Loy	Inter	Compo- sition	Tic (2.5)	TiC (2.1)	TiC (2.1)	TIC (4.0)		Tic	(1.2)		Tic	(5.5)		TIN	(1.8)			Tic	(5.9)			TICN	1.1			(2.5)	 :
Hard Coating Layer	Layer	Orientation	(111) (200) (220)	(220) (200) (111)	(111) (200) (220)	(200) (220) (111)		(111) (200) (220)			(220) (200) (111)			(200) (220) (111)				(1111 (200) (220)				(220) (200) (111)				Granular (111) (200) (220)	
	Inner Layer	Crystal Struc-	Granular	Granuler	Granular	Granular		Granular			Granular			Granular				Granular				Granular				Granular	
		Compo- sition	TiCN	Ti Co	TiCN (9.5)	TiCN		TiCN	(4.8)		TiCN	(8.8)	_	TiCN	(3.2)			NO:F	(3.5)			TiCN	(2.7)			5 5 S 5	:
	innermost Layer	Crystal Struc-	Granular	Granular		Granular		Granular			Granular			Granular				2 1 1 1 1 2 2								Granular	
	Lunermo	Compo- sition	Tin	Tin		Tic.	(1.2)	Tin	17.13		Tin	(0.1)		J. F	(9.6)			£	6	:						S E	ĵ.
Ġ	strate Symbol		<	4	4	6		m			U			,	,			٤	>			٥	,			٥	
			29	or.	Ä	35		2			34			ž	;			Ţ	2			-	;			e	
	Туре									Coored	Cemented	Cutting	Tools of Prior Art														

Flank Wear	Ê		Incerrupted	Cutting		r 19.7 min.	guj		r 19.3 min.	Separation		Failure	after 0.1	min. due to min. due to	Fracturing	Failure	after 0.3	min. due to min. due to	107000000
Flank	(66)		Cont initial	Cutcing		Fallure after 19.7 min.	due to Chipping	(Milling)	Granular Failure after 19.3 min.	due to Layer Separation	(Milling)	Failure	after 1.4	min, due to	Chipping	Failure	after 3.2	min. due to	
	Outermost Layer		Cryeral	Struc-	ture				Granular			Granular Failure				Granular Failure			
	Outers	_		Compo-					T.N	9.3		ri F	(0.3)			Tin	(0.2)		
	Outer Layer		The second of th	Struc-	ture	a:1001			α: 100¢			0.1001				α:1001			
	Outer		1000	sition		A1203		6.5	A1203			A1201		5		۸1203		:	
er	First	Intermediate		Struc-	ture	Granular			Granular			Granular				Granular			
ing Lay	4	Inter		Compo	5	Tic	(1.4)		Tic	(1.5)		TiCN	(1.4)			Tic	(1.11		
Hard Coating Layer	Inner Layer			Orientation	•	Granular (220) (200) (111)			TiCN Granular (111) (200) (220)			Tick Granular (220) (200) (111) Tick				Granular TiCN Granular (111) (200) (220)			
	Inner			Struc-					Granular			Granular				Granular			
				Compo-	ait ion	20.5			NO IJ	(3 6)	•	T.C.	4	;		Tich	5		
	Innermost Layer			Compo- Crystal	3 3 3 3	Granular										Granular			
L	Innerm	:		Compo-		ž		3								N. F	2 1 1 1		(0.7)
Sub.	Strate	Symbol				-				,		2				·	,		
						٩	ì	_	Ş	_		;	;			;	,	_	- -
	200	-					-		1	2000	Cemented	Caratoe	601130	10018 001	Pr:0: Arc				
			-																•

TABLE 9 (b)

TABLE 10

						1							
						наго	Hard Coating Layer	<u>u</u>					
Туре		Substrate Symbol		inner Layer	Layer	Interme	Second Intermediate Laver	Out	Outer Layer	Outern	Outermost Layer	5	riank wear (mm)
			Compo-	Crystal	Orientation	Compo-	Crystal	Compo	Crystal	Сошро-	Crystal	Continuous	Interrupted
	7	4	30,5	₽	╀		or occure	S10100	Structure	Sition	Structure	Cutting	Cutting
			(8.4)	Growth	(111) (220) (200)	TicNo (0.1)	Granular	A1203	K:948	Tin	Granular	0.15	0.17
	4	«	TiCN (5.7)	Elongated Growth	(220) (111) (200)	TiCNO	Granular	A1203	K: 851			0.16	6.17
	ŝ	4	F. C.	E) oncared	1000/1000/1111/	200		0 9					
			(11.4)	Growth		(0.1)	Granular	A1203	K:1001	Ticn-	Granular	0.15	0.19
_	ļ	1								(0.6)			
	9	n	(8.2)	Growth	(111) (200) (220)	TiCNO (0.1)	Granular	A1203	K: 1008	Tin	Granular	0.14	0.20
Coated	47	B	TiCN	Elongated	(1111) (220) (200)	Tico	Granular	A1203	K: 731			0.17	91.0
ייייייייייייייייייייייייייייייייייייייי	1		(3.0)	Growth		(0.2)		(5.3)					
Cutting	4 D	u	71CN	Elongated	(220) (111) (220)	Tico	Granular	A1203	K: 55%	Tin	Granular	0.18	0.21
	9	,		1				(1.2)		(0.3)			
	<u>.</u>	,	7. T.	Elongated	(220) (200) (111)	Ticno	Granular	A1203	K: 62%	Tin	Granular	0.22	0.23
100	Ş			מו מורנו				(6.9)		(0.4)			
	3		(6.5)	Growth	(200) (200)	TiCNO	Granular	A1203	K: 94%	Tin	Granular	0.13	0.18
	51	۵	TiCN	Elongated	(220) (111) (200)	ON U.S.				10.21			
	1		(3.8)	Growth		(0.1)	Granutar Granutar	A1203	K: 62%			0.12	0.21
	25	۵	7iCN	Elongated	(111) (220) (200)	TiCNO	Granular	A1203	2000			;	
1	1		(2, 7)	Growth		(0.1)		(2.4)	¥1001:4	-		5	0.19
-		យ	Ti Cr	Elongated	(220) (111) (220)	TICNO	Granular	11201	K. 1008			13.0	
	+		<u>-</u>	Growth		(0.1)		(9.0)			_		. Gurrina
_		ù	Z L	Elongated	(111) (220) (200)	TICNO	Granular	A1203	K : 948	Tin	Granular	31.0	(Millian)
1	+		(4.0)	Growth		(0.1)		(0.5)		(0.3)			-
	<u>,</u>	2	 2 3	Klongat.ed	(220) (111) (200)	Tico	Granular	10٪ ۱۸	N: 1001	Tin	Granular	0.12	0.18
<u>J</u>	5	0	3	P. 1.20001.0	,000,000,000,000,000,000	7 1	+	(0.3)					
	;	,		parefucts	(002) (022) (111)	TICNO	Granular	A1203	K: 948	TIN	Granular	0.13	0.17

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TABLE 11 (a)

Wear	-	Interrupted	0.54	(Chipping)	0.51 (Chipping)	0.55 (Chipping)	Failure	after 11.1	Layer	Separation	Failure	aiter 7.5 min. due to	Layer	Separation	Failure	min. due to	Fracturing		Failure	min. due to	Practuring		Failure	ofter 11.4	min. due to	chipping	Failure	ofter 0.5	min. due to Chipping	Failure	after 10.1	min. due to Chipping
Plank Wear	(mm) .	Continuous	0.42	(Chipping)	0.47 (Chipping)	0.43 (Chipping)	Pailure	ofter 17.5	Laver	Separation	Failure	min. due to	Layer	Separation	Failure	min. due to	Layer	Separation	Failure	min. due to	Laver	Separation	Failure	after 20.7	min. due to	Chipping	Failure		min. due to Chioping	Failure	after 16.3	min. due to
	Outermost Layer	Crystal	Granilar			Granular	Granular								Granular				Granular				Granular									
	Outermo	Compo-	31,100	(0.4)		TICN- TIN	Z	(0.3)							T.L	(0.2)			Tin	(c.0)			Tis	(0.3)								
	Outer Layer	Crystal	Structure	α:1004	a:100%	X: 404		a: 1004			a: 1001				α:1001				K: 40%				1000				K . 404	:	•	1001.2	1001:50	
	Onter	Compo-	Sition	A1203	A1203	A1203	3	(2.0)			A1203	(5.2)			10214	1.3			A1203	(6.9)			517	3 5	:	,	100 LA	(8.1)		6	(2,3)	
Hard Coating Layer	Second	Compo- Crystal	Structure	Granular	Granular	Granular		Granular			Granular		-		Granular	•			Granular				Granitar				Granular			10000	18 10 10	
Hard Co	Sec	Compo-	strion	TiCNO (0.1)	TICNO	TiCNO (0.1)		(0.1)			Tico	(0.2)			Tico	(0.1)			Ticno	6.1			0,000	21			CNO: F	(0.1)		0,0	6.13	: :
	yer	Orientation		(111) (200) (220)	(220) (200) (111)	(111) (200) (220)		(200) (220) (111)			(111) (200) (220)				(220) (200) (111)				(200) (220) (111)				10.00	(111) (200) (220)		-	1111,1000,1000	(****) (***)			(111) (200) (270)	
	Inner Layer	Crystal	Structure	Granular	Granular	Granular		Granular			100000	10.00			Granular				Granular					Granular				Granular			Granular	
		-00000	sition	TiCN	TICN	TiCN		7.C	5.6.			2 8. 2 5.			2014	(10.3)			20,6	(5.2)	:			S.	(9.9)			ž.	: :		TICN	(7.8)
	Substrate	Symbol		4	<	a		Ð				m				,			ļ	,				C				0			٥	
				\$	3	\$		9.				47		·		ē			ŀ	, .		_		20	_			Ş			25	
	Type													Coated	Cemented	Carbide	Tools of	Prior Art														

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TABLE 11 (b)

						Hard C	Hard Coating Layer					Flank	Flank Wear
1Vpe		Substrace		Inner Layer	ayer	Š	Second	Oute	Outer Layer	Outerm	Outermost Layer	(mu)	Ē
		Control				Intermot	ntermediate Layer						
			-00000	Crystal	Orientation	Compo-	Crystal	Compo-	Crystal	Сощоо	Crystal	Continuous	Continuous Interrupted
			sition				٠.	sition	Structure	sition	Structure	1	Cutting
	5	4	2016	Granular	(220) (200) (111)	TICNO	Granular	A1203	a: 100%			Fallure after 26.9 min.	r 26.9 min.
	3	,	(4.2)					(0.5)				due to Chipping (Milling)	ing
٠	ŀ		1	1,000,00	(1111/2001/2201	CNU	Granular	10014	W.1004	Tiv	Granular	Granular Failure after 24.2 min.	r 24.2 min.
Coated	7	ن	(4.0)					(0.4)		(0.3)		due to Layer Separation	Separation
opide.					•							(6111114)	
רפוחות	ᆚ		20:1	Granular	(220) (200) (111)	1100	Granular	1120ء	001:00	Tin	Granular Fallure	Fallure	Failure
Carring	2		; ; ;			(0.1)				(0.4)		alter 2.0	ofter 0.2
Tools of												min. due to	min. due to min. due to
Prior Arc												Chipping	Fracturing
	Ī	ļ	Ž.	101.101.	(1111/2001/220)	TiCNO	Granular	A1501	0.1001	Hin	Granular Pailure	Pailure	Failure
	å	,	3 6					(0,8)		(0.2)		after 5.2	after 0.7
	_											min. due to	min. due to
												Chipping	Fracturing

TABLE 12

	1	, , ,	_								·		÷.			
Flank Wear	(mm)	Inter- rupted Cutting	0.14	0.13	0.15	0.16	0.17	0.19	0.21	0.15	6:17	0.15	(hilling)	(Killing)	91.0	0.15
Flan	-	Conti- nuous Cutting	61.0	\$1.0	0.14	0.13	0.16	0.17	0.20	0.12	0.11	0.13	0.12	0.14	0.11	0.11
	Outermost Layer	Crystal Structure	Granular		Granular	Granular		Granular	Granular	Granular				Granular	Granular	Granular
	Outermo	Compo- sition	TIN (0.5)		TICN- TIN (0.7)	TiN (0.3)	-	TIN (0.3)	Tin (0.5)	TÍN (0.2)				Tin (0.3)	TIN (0.5)	Tin (0.2)
	Outer Layer	Crystal Struc- ture	K:948	K:858	K: 1004	K:1001	K:738	K:551	K:624	K: 941	K: 621	K: 1004	x:1001	K: 948	K: 1001	N: 941
	Outer	Compo- sition	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203
	Second Intermediate Layer	Crystal Struc- ture	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granulor	Granular	Granular
ing Layer	Sec	Compo- sition	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)	T1C0 (0.2)	41CO (0.1)	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)	TiCO (0.1)	TiCNO (0.2)
Hard Coating Layer	yer	Orientation	(111) (220) (200)	(220) (111) (200)	(111) (220) (200)	(111) (200) (220)	(111) (220) (300)	(220) (111) (200)	(220) (200) (111)	(111) (220) (200)	(220) (111) (200)	(111) (220) (200)	(220) (111) (200)	(111) (220) (200)	(220) (111) (200)	(111) (220) (200)
	Inner Layer	Crystal Structure	Elongated	Elongated	Elongated	Elongated Growth	Elongated	ō								
		Compo- sition	TiCN	71CN	TiCN (11.5)	TiCN (8.2)	TiCN (4.9)	TiCN	TiĆN (5.3)	TiCN (6.4)	TiCN (3.8)	71CN	TiCN	TiCN	TiCN (4.6)	T1CN
	Innermost Layer	Crystal Struc-	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular
	Innermo	Compo- sition	Nit.	z i c	1).CN	Tic- Tin	Tin	z i	Tic	TiN (0.6)	TiN (1.2)	TiCN (9	Nit o	TiN	Tin (7.0)	1 1 N
. Gub	strate Symbol		4	<	4	æ	۵.	u	U	۵	۵	۵	:0	iu	64	U
			5	85	65	9	19	3	G	64	8	3	5	89	69	۶
	Туре			4	··••··································		Coated	Carbide	Tools of	Invention	•		_			

TABLE 13 (a)

			_										
Wear	Ê	Interrupted Cutting	0.51 (Chipping)	0.49 (Chipping)	0.54 (Chipping)	Failure after 12.3 min. due to	Layer Separation	Failure after 8.6 min. due to Layer Separation	Failure after 1.7 min. due to Fracturing.	Failure, after 5.9 min. due to Fracturing	Failure after 12.3 min. due co Chipping	Fallure after 9.3 min. due to Chipping	Failure · after 16,8 min, dur 19 Chipping
Flank Wear	(can)	Continuous	0.38 (Chipping)	0.41 (Chipping)	0.40 (Chipping)	Failure after 18.8 min. due to	Layer Separation	Failure after 15.1 min. due to Layer Separation	Failure after 9.0 min. due to Layer Separation	Failure after 14.6 min. due to Layer Separation	Failure after 21.4 min. due to Chipping	Failure after 13.5 min. due to Chipping	Failure after 17.1 min. due to Chipping
	Outermost Layer	Crystal Struc- ture	Granular		Granular	Granular			Granuler	Granular			
	Outerm	Compo- sition	TIN (0.5)		TiCN- TiN (0.6)	TiN (0.3)			TİN (0.3)	TîN (0.6)			
	Layer	Crysta 1 Struc-	a: 100%	a: 100%	K: 408	a: 1001		a: 100%	a: 1001	K:408	α:1001	K:40%	a:1001
	Outer Layer	Compo- sition	A1203	A1203	A1203	A1203		A1203 (5.0)	A1203 (5.0)	A1203	A1203	A1203 (8.2)	A1203 (2.3)
	Second . Intermediate	Crystal Struc. ture	Granular	Granular	Granular	Granular		Granular	Granular	Granular	Granular	Granular	Granular
g Layer	Sec	Compo- sition	TiCNO (0.1)	TiCNO (TiCNO (0.1)	TiCNO (0.1)		TiCO (0.2)	7ico (0.1)	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)
Hard Conting Layer	ayer	Orientation	(1111) (200) (220)	(220) (200) (111)	(111) (200) (220)	(200) (220) (111)		(111) (200) (220)	(220) (200) (111)	(200) (220) (111)	(111) (200) (220)	(220) (200) (111)	(111) (200) (220)
	Inner Layer	Crystal Struc- ture	Granular	Granular	Granular	Granular		Granular	Granular	Granular	Granular	Granular	Granular
		Compo- sition	TiCN (8.4)	TiCN (5.3)	TiCN (11.3)	TiCN :	-	TiCN (4.8)	TiCN (10.2)	TiCN (5.4)	TiCN (6.6)	11CN (3.9)	TiCN (7.7)
	Innermost Layer	Crystal Struc- ture	Granular	Granular	Granular	Granular		Granular	Granular	Granular	Granular	Granular	Granular
	Innermo	Compo- sition	Nit C	rit 0	TiCN (0.7)	TIC-	3	Tin (1.6)	Tin (0.1)	Tic (0.4)	TiN (0.5)	Tin (1.3)	TiCN (0.5)
	strate Symbol		<	<	4	6		æ	U	U	۵	a	٥
			52	88	53	9		. 61	62	9	64	5.9	99
	Туре			•		•		Coated	Cutting Tools of Prior Art				

TABLE 13 (b)

_		_]	ē			_		╗	_	_	Т	_		0	Ţ	_	_	2	٦
;	vies r	ê		interrupted		rate in the	r 28.0 min.	ing		r 24.8 min	Constation		Failure	after 0.2	min. due	Fracturing	Failure	ofter 0.9	min. due	Fracturing
;	Flank Wear	Ē.		anona junos	COLCAMORE	Cutting	railure after 28.0 min.	due to Chioping	(Hilling)	Cracilar Failure after 24.6 min.	And to I such Constation	(Milling)	Pailure	after 2.5	min. due to min. due to	Chipping	Failure	After 5.7	min. due to min. due to	Chipping
		Outermost Layer			Crystal	Struc- ture				1811191	10101010		Granular Pailure				Cracular Failure			
		Outermo				rition				1	2	(6.3)	2:4		2		1		3.0	
		Outer Laver			Crysta			α: 100			a: 100%			a: 1001			4	α:1001		
		20110			Compo-	sition		۸1203	(0.6)		A1203	(0.4)	١.	A1203	(0.4)		-1.	A1203	(0.9)	
			Second Intermediate	Layer	Crystal	Struc- ture		TiCNO Granular			TiCNO Granular			Granular				Granular		
	ig Layer		Sec	La		Compo- sition		TiCNO	(0.1)		TICNO	(0.1)		13	(0.1)			TICNO	(0.2)	
	Hard Coating Layer		yer			Orientation		(111)			(022) (002) (111)	(007) (111)		(220) (200) (311)				(111) (200) (220) TÍCNO Granular		
			Inner Layer			Crystal Struc-	-	1				Granutar		Granular				Granilar		
						Compo- Crysta sition Struc-		_	2 5			7 C		20.6				E E		
			Innermost Layer				Cure		Granular			Granular		1	Grandian				Granular	
			Innerm			Compo- sition				3.5		Ni'r	7		V 1.	: :			2	200
		4.0	strate	Symbol					ω			. 3			Œ				G	
	F			_					67			89			69		_		2	•
			Type									Coated	Cemented	Carbide	Cutting	Tools of	Prior Art			
	L	_			_		_	_		_	_	_	_		_		_			

TABLE 14

	-						Hard Coating Layer	ng Layer						i	
	ű	- Pi												Flank Wear	Near
•	, ;			Inner Laver	iver	Pi	First	Sec	Second	Outer Layer	Layer	Outerm	Outermost Layer		-
adkı	n vo	Symbol				Intern	Intermediate	Interm	Intermediate						
	_	_				2	Layer	ì.	rayer		1	100000	10,000	5005	Inter
_			-odwoo	Crystel	Orientation		Crystal	Compo-	Crystal Struc-	Compo-	Struc	sition	Structure	\$nonu	rupted
			sition	Struc-		316101	ture		ture		ture			Cutting	Cutting
	1-	4	Ticn	Elongated	(111) (220) (200)	Tic	Granular	Ticno	Granular	A1203	K1948	TÎN (0.2)	Granular	0.16	0.20
		_	(6.3)	Growth		(3.5)		,	1	1		Ì		0 10	0.19
	72	<	TiCN	Elongated	(220) (111) (200)	7iC	Granular	7iCNO	Granular	A1203	K: 85			:	
	- -	1	NU.E	Flongated	(111) (220) (200)	Tic	Granular	Ticno	Granular	A1203	K: 1001	TiCN-	Granular	0.16	0.21
	•	•	(9.4)	Growth		(5.0)		60.1		(3.1)		(0.7)			
	1	1	20.6	paracola	(1111) (200) (220)	Tic	Granular	Ticno	Granular	A1203	K: 1008	TIN	Granular	0.15	0.23
	~	<u> </u>	(4.6)	Growth		(3.8)		(0.1)		(3.0)		6.3			,
Coated	5.	_	TiCN	Elongated	(111) (220) (200)	TiC (1.4)	Granular	T1C0	Granular	A1203	K: 731			0.19	0.21
Cemented	1;	,	2015	Flondared	(220) (111) (200)	Tic	Granular	T1C0	Granular	A1203	K: 551	TIN	Granular	0.20	0.24
Cutting	9	 J	(6.6)	Growth		(1.1)		(0.2)		19.11		(0.3)		,	,
Tools of	1.	Ü	TiCN	Elongated	(220) (200) (111)	Tin	Granular	TICNO	Granular	A1203	K: 62%	7.5 (0.5)	Granular	6. 53	G. 5
che	_ !		(3.3)	Growth				(1.0)	1	1	1	Z j	Granular	0.15	0,19
Invention	7.8	a	TiCN	Elongated	(111) (220) (200)	Tic (2.9)	Granular	(0.1)	Granular	(5.2)	K: / J&	(0.5)			
	۶	-	TICN	Elongated	(220) (111) (200)	TICN	Granular	Ticno	Granular	A1203	K: 621				0.22
•	:	1	(5.4)	Growth		(0.6)		9.13		(9.6)					
	2	٥	TiCN	Elongated	(1111) (220) (1111)	Tic	Granular	TiCNO	Granular	A1203	K: 1001			<u> </u>	136
			(5.5)	Growth		(0.7)		1		7 7				51 0	(Millino)
	ā	з	TICN	Elongated	(220) (111) (200)	7 T	Granular	TICNO	Granular	A1203	x: 100				
			(5.5)	Growth						7		Z) E	Granular	0.17	(Mil. ir.g).
	82	:3	Ticn	Elongared	(1111) (220) (200)	ر ا ا	Granular	TICNO	Granutar .	627	16 K : 34	(0.2)			
			2.3	Growth					32		1	Z	Granular	0.14	0.20
	83	L	Ti Cr	Elongated	(220) (111) (220)	11CN	Cranula:	(0.1)		6.4	• • • • • • • • • • • • • • • • • • • •	(0.3)			
	1		7 Z	Flongated	(111) (220) (200)	Tic	Granular	TICNO	Granular	A1203	K:948	Tin	Granular	0.13	61.0
	- -	,	: :	Greweh	_	6.5		(0.2)		(0.0)		(0.3)			

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TABLE 15 (a)

Flank Wear	(m)	Interrupted Cutcing	0.53 (Chipping)	0.52 (Chipping)	0.40 (Chipping)	Failure	atter 9.5 min. due to Laver	Separation	Pailure after 6.3	min. due to	Layer Separation	Failure	after 1.2	Fracturing	Failurz	ofter 4.4	min. Jue to	Fracturing	Failura'	after 9.5	min. duc co	Chipping	1011011	min. due to	Chipping	Failure	after C.4	Chipping (*)
Flank	<u>s</u>	Continuous Cutting	0.43 (Chípping)	0.49 (Chipping)	0.37 (Chipping)	Failure	min. due to	Separation	Pailure after 12.1	min. due to	Separation	Failure	after 6.8	Layer	Failure	after 11.9	min. due to	Layer Separation	Failure	_	2	Chipping		_	_	H	_	Chipping to
	Outermost Layer	Crystal Struc- ture	Granular		Granular	Granular						Granular			Granular				Granular						_		<u></u> -	
	Outer	Compo- sition	Tin (0.3)		TiCN- TiN (0.6)	Nit.						Tin	60.4		Tin	(0.4)			Tin	(0.3)		T						
	Outer Layer	Crysta 1 Struc- ture	α: 1001	α: 100 1	K:401	a: 1001			a: 1001			a: 1001			K . 404				a: 1001			,,00	,			a: 1001		
	Outer	Compo- sition	A1203	A1203	A1203	A1203	(1.9)		A1203			A1203	(1.2)		A1201	(0.0)			A1203	(5.1)		A1503		3.5		A1203	15.51	
٠	Second Intermediate Layer	Crystal Struc- ture	Granular	Granular	Granular	Cranular			Granular			Granular			Granular				Granular			Granular				Granular		
ng Laye	Se Inter	Compo- sition	TiCNO (0.1)	T1CNO (0.1)	TiCNO (0.1)	TICNO			0;t 0.1.0			Tico	3.0		TICNO	(0.1)		,	1-	(0.1)		TICNO	_			_	(0.2)	
Hard Coating Layer	First Intermediate Layer	Crystal Struc- ture	Granular	Granular	Granular	Granular			Cranular			Granular		_	Granular				Granular		_	Granular			\rightarrow	Granuler		
	Inte	Compo- mition	Tic (3.2)	Tic (2.0)	TiC (2.1)	TiC			Tic. 1.2)			TIC	(6.3)		Tin	(1.8)			Tio.	(5.8)		TiCN	1.3			Tic	(2.5)	
	Layer	Orientation	(111) (200) (111)	(111) (200) (271)	(111) (200) (220)	(200) (220) (111)			(111) (200) (220)			Granular (220) (200) (111)		-	(200) (220) (111)				(1111) (200) (220)			(220) (200) (111)				(1111) (200) (220)		
	Inner Layer	Crystal Struc- ture	Granular	Granular	Granular	Granular			Granular			Granular			Granular				Granular			Granular				Granular		
		Compo- sition	TiCN (6.2)	TiCN (1.0)	TiCN (9.3)	TiCN (4.7)			13.CN			TiCN		٠	TiCN	(3.2)			TICN	(3.4)		Ticn	(5.4)			Lich	(5.3)	
Sub-	strate Symbol		۷	٧	٧	n			m			υ	,		U				٥			°				2		
		•	7.1	72	13	74			. 75			9,6			٤				9			6				80	_	
	947.									Coated	Carbide	Cutting	Prior Are													•		

		Flank Wear (mm)		Interrupted	Cutting		r 23.2 min.	ing		r 20 1 min	Separation		Failure	after 0.1	min. due to	Fracturing	Failure	after 0.3	Ain die
				Continuous	Cutting		Failure after 23.2 min.	due to Chipping	(Milling)	Granular Failure after 20 1 min	due to Leyer Separation	(Milling)	Pailure	after 1.6	min. due to	Chipping	Failure	after 3.5	min, due to min due to
		Outermost Layer	•	Crystal	_	ture				Granular			Granular Failure				Granular Failure		
		Outer		L	elt for					Z.F	(0.2)		_	(0.5			Z.	(0.3)	
		Outer Layer		Crysta	- 6	Scruc- ture	a: 1001			a: 1001			a: 1001				a: 1001		
		Outer		Сощоо	sition		۸1203	(0.4)		A1203	(0.4)		V1203	(0.3)			. A1203	(0.7)	
		Second	Laver	Crystal	Struc-	9	Granular Ticno Granular			Granular			cranular			1	oranutar A1203		_
	ing tay	Sigi	-	ė	sition		Ticno	7.5		•	(1.0)	007		; ;		T i Chi	0 2		
United Contract	maid codting tayer	First Intermediate	Layer	Crystal	ture		Granular			Cranular		TiCN Gradular	1010			Granular			
		Inte	_	Compo	*ition		Tic Tic	:	1	; ;	;	4				ijĻ			_
		Inner Layer		Orientation			Granular (220) (200) (111)		Cranciar (111) concre	10221 10021 17771		Granular (220) (200) (111)				Granular (111) (200) (220)			
		Inner		Compo- Crystal	cure		Granular		Granular			Granular				Granular		-	
			Compo- sition		i	(2.4)		TiCN	(2.5)		TiCN	(3.3)			TiCN	. B.			
L	Sub-	Symbol Symbol				,	J					L				<u>_</u>			
						1			82			93				84	<u>.</u>	_	_
		ayye							Coated	Cemented	Carbide	Cutting	Tools of	Prior Art					
•																			

TABLE 15 (b)

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TABLE 16

ink Wear	(mm)		0.19	0.18	0.20	0.22	0.13	0.23	0.24	0.13	0.21	0.20	(Mt.11;ng)	(Hilling)	6.13	0.18
î.		Continuous	0.15	0.17	0.15	0.14	0.18	0.18	0.23	0.13	0.13	0.14	0.14	0.16	0.13	0.13
	ermost	-	Granular		Granular	Gramular		Granuler	Granular					Granular	Granular	Granular
		Compo- sition	TiN (0.2)		TiCN-	TiN (0.2)		Tin (0.3)	Tis					7 in	4 in	TiN (0.2)
	r Layer		K: 948	K: 85%	K: 1001	K: 1001	K:738	K:551	K:621	K: 731	K: 621	K: 1001	K: 1008	K:941	K: 1001	N: 941
	Oute	Compo- sition	A1203	A1203	A1203	A1203	۸120)	A1203	A1203	A1203	A120,	A1203	A1203	A1203	A1203	A1203
	econd rmediate ayer	Crystal Struc-		Granular Granular	Granular											
	Inte	Compo- #itfon	TICNO (0.1)	TiCNO (0.1)	T1CNO (0.1)	TiCNO (0.1)	71C0	Tico (0.2)	TiCNO	TiCNO	TiCNO (0.1)	TiCNO (0.1)	TiCNO (0.1)	Ticno (0.1)	7iCo	TÍCNO (0.2)
	irst mediate ayer		Granular	Granular	Granular	Granular	Gramlar	Granular	Granular	Granular	Granular	Granular	Granular	Gramular	Granular	Granular
	Intel	Compo- altion	11C	Tic (2.3)	TiC (2.1)	71c (3.8)	TiC (1.2)	Tic (3.0)	Tin (1.1)	TiC (2.8)	TiCN (1.2)	TiC (2.5)	Tic (1.4)	71C (1.5)	15CN (1.4)	Tic (1.0)
	ayer	Orientation	(1111) (220) (200)	(220) (111) (220)	(1111) (220) (200)	(111) (200) (220)	(111) (220) (200)	(220) (111) (200)	(220) (200) (111)	(111) (220) (200)	(320) (1111) (200)	(111) (220) (200)	(220) (111) (200)	(111) (220) (200)	(220) (111) (200)	(111) (220) (200)
Tonor.	James	Crystel Structure	Elongated Growth	Elongated Growth	Slongated Growth	Elongated Growth	Elongated	Elongsted Growth	Elongated	Elongated Growth		Elongated	Elongated Growth	Elongated Growth	Elongated Growth	-
		Compe- sition	TiCN (6.4)	TiCN (3.0)	TiCN (9.2)	1.5. 1.7.	TiCN (4.8)	TiCN (6.7)	TiCN (3.2)	TiCN (3.6)	1'iCN (2.3)	TiCN (5.4)	TiCN (2.6)	Tick (2.5)	TiCN (3.2)	1;CN
ormost.	ayer	Crysta) Struc- ture	Granuler	Granular	Granuler	Granular	Granular	Granular	Granular							
L		Compo- sition	Tin (0.8)	TiN (0.4)	TICN (0.7)	TiC. TiN (1.2)	T'IN (1.5)	71:N (1.0)	TiC (7.0)	TiN (0.6)	TiN (1.0)	TiCN (0.4)	TiN (0.3)	TiN (0.3)	TiN (0.5)	Tich
strate	Symbol		4	< ·	<	fi .	0	C	Ú	٥	٥	۵	э	ü	ís.	9
			8.5	8	8.	.	68	90	9.1	92	93	94	Sé	96	97	86
Type						-	Conted .	Carbide	Tools of	Invention				•		
	Strate Innovement	Innermost Inner Layer First Second Outer Layer Outermost Layer Layer Layer Layer	Structure Struct	Symbol Layer Innermost Inner Layer Intermediate Intermediate Intermediate Layer Laye	Symbol Layer Innermost Layer Innermediate Second Outer Layer Lay	Strate Innermost Layer Layer Intermediate Intermediate Intermediate Intermediate Intermediate Intermediate Layer Symbol Layer Layer	Symbol Layer Layer	Symbol Layer Lay	Simple Innermost Innermo	State Intermediate Intermediat	State Layer Layer Layer Layer Layer Layer Layer Layer Layer Components Prop. Strate Innermost Layer Inner Layer Intermediate Incomediate Composition Comp	Single Single Innermost Innermost Intermediate Incomediate	Part Part			

	ſ			_					•										•										
5		Flank Wear	(mm)		5	Chipping)	0.50 (Chipping)	0.39 (Chipping)	lou da	efter 9.8	2	Fellure efter 6.1	min. due to	Failure	win. due to	Failure ofter 4.2	Min. due to	Fallure	Min. due to	rellure felter	min. due to	Failure atter 8.7	aln des to Chipping	1.7 min. (Milling)	0 7 810	Fellure	efter 0.1 min due to	failure	0. due to
10				Cont i prome	Cuttino	Chipping	0.48 (Chipping)	0.35 (Chipping)	Fei lure	after 15:1	Separation	Fallure efter 12.6	Layer	Failure after 7.1	ain. due to	Failure after 12.5	•	7	ain. due to	Γ.	:	_	Chipping	due to Chipping (Hilling)	Pellure after 20 7 min.		after 1.8 and anim. due to mi	Τ.	•
			most	yetal	Struc- ture	Granular		Granulae		Granuler				Gramilar		Granular		T			•		5	2-8	 	_		 	_
			Outermost	Compo	_			-	-+-	10.21	4			+		-		+		_	4		\downarrow		Granular		1417	Granular	
15				_		-+	-				4			Nit.		7 F 0									Tiv	Z.F	<u>.</u>	Z C	
			Outer Layer	Crystel			a: 100	X:40	α: 100		-+	a: 100%		a: 1004		K:401		a: 1001		K: 404		a: 1001		a: 1001	a: 1001	α: 1001		a: 1001	
20				Control		-	-	2.29	A1203	: B)		13.81		A1203		A1203		A1203	(2.0)	A1203	ģ	2.61	6	5 5	A1201	┿	(0.4)	A1203	
	17		Second Intermediate Laver	Crystal			Granuler	Oranular	Granular			Granular		Granular		Granuler		Granular		Granulae	-+-	Cronciat	+	Granuler	Grenuler	Granulor		Granuler A	
<i>25</i>	ш		12.	Compo	TICNO	1 (S. 1)	(0.1)	(0.1)	Ticho		9 1	(0.1)		71C0		71CNO		TICNO (0.1)		(0.1)	TICNO		TICNO	-4	(0.1)	7100		11CNO 10.21 Gr	\dashv
	TABL Hard Coating Layer		rirat Intermediate Layer	Crystal Struc.	Granular		Granular	Granular	Granular		1	Granular	1	Granular	1	Granular		Granuler		Granular (- -	Granuler	+-	Cranular 10	Granular (0	 -			\dashv
	rd Cos		Luter 2	Compo- oltion	Tic		-+-	12.21	71c		-	3.5.	1	11C	+		-		- 2		+		+-	-+-	_	Granuler	1	Granular	
30	ž	-			+-		+		┼—		┰		+			- C - C - C - C - C - C - C - C - C - C	\downarrow	(2.9)	E		+	(2.4)	Tic	= =	11.53	TiCN	Ę	2.5	
<i>35</i>		Inner Layer		Ortentation	(111) (200) (220)	133017300		(111) 12001 1220	(200) (220) (111)			111111201117701		(220) (200) (111)		(200) (220) (111)		(1111)(2001(220)		(220) (200) (1(1))	131111200112201		11111100111021		111111200112201	122011200111111		()[[](200)(220)	
		Inner		Crystal Struc.	Granuler	Granular		a louis	Cranulae		Granulas			Granular	-	Granular	+	Granular	+	Creme las	Granuler		-		-+		┯		$\left\{ \right.$
				Compos- artion	TiCN (6.9)	F C		-+	TiCN [4.5]		TICN		_	(6.5)		 	2		┯		-	\rightarrow	Cranular	+	2 Cranular	Cranitae		Grantler	-
40		يا	1		├	┼-	+-	-			 -		+-		+-		L NO.		TiCN		E S	1	ر د د د د	+	+	2.5	TICN	*. =	
		Innermont	Š	ture	-	Granular	+		Granutae	_	Granulas			Granular				Cranular			Granular		Granular	200		Granular			
45		L		Sitte Sitte	10.9	¥ 6	F .C	2 4		-	2 3		Tis	10.1	11.0	(O. B)	Tin	(0.5)	Ni.	(6.9)	71CN		2 5	2 F	2 2	5	-	; 6 ; 6	
	ģ	SCHOL			۷	<	<	-	-		a		ľ		U				٥		۵	+		iu	i.		Jo		
		ž·			8	98	t's	ا ا	C		o.		ŝ		2		2		2		5	3	:	56	7.		96	-	
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TABLE 18 (a)

			Forth Divided Laver	la la la la la la la la la la la la la l			4	-		<u> </u>								111		:		Elonystyd
			\vdash	+-	eit ion	2 5	-	_	_	_		Ŀ									TICN	<u>-</u>
			Third Dividing	Crystel	Struc.	Granuler					•										Cramiler	
			\perp	Compo	eic ion	(0.5)												1	7		Nit o	_
			Third Divided Layer	Crystel	Structure	Slongated	T CONTRACTOR				Crowth			Elongated Growth		Floorered	Growth	Growth	1		ļ ,	_
			Third	Compo	E S	(2.4)				Tich	(5.6)		TiCN	(3.8)		Tich	TiCN Ti	2.4	\dashv		TiCN	_
ayer		Inner Layer	Second Dividing	Crystal	_	Granular					or amular			cranular		Granuler	Grameter	+			Granuler	_
Hard Coating Layer		In	Secon	odeso:		_				Tin	(0.2)		Tin	9.5	_	Tin	+	-1-	1	7	4in (0.2)	
Hard Co			Second Divided	Crystal		Growth	Elongated	Elongated	Growth	Growth	Growth	Elongated Growth	Flondared	Growth	Elongated	Elongated	Growth Elonget ed	Growth Elongated	Growth	Growth	Elongated	
			Beco	Compo-	TiCN	(2.4)	TiCN (3.0)	Tick	3 G	7. P.		(2.3)	T) CN	2 7	(8.8)	TICN (0.8)	Tich	+-		╁	(1.8)	
			First Dividing Layer	Crystal Struc-	ture	3870000	Granular	Granuler	Granuler	Granular		Granular	Granular		Granular	Granuler	Granular	Granular	Gramular	-	Granuler	
	1		First	Compo- sition	Tin	9	TiN (0.2)	Tin (0.2)	7 is	Tin	2	(0.3)	Tin	Z Z	_	10.11	7 i N		┿	7 2 F	_	
			First Divided Layer	Crystal Structure	Elongated	Growth	Elangat ed Growth	Elongated	Elongated	Elongated	Greath	Growth	El onget ed	Growth	Elongated Growth	Elongat ed Grewth	7	-	+-,		Elonget ed (
	L		First	Compo- sition	TiCN	7 7	. O. C	TiCN (3.2)	TiCN (3.1)	TiCN (2.7)	Ticn	(2.2)	7 i CN	FICN	12.7	1. Cv	TiCN (2.5)	TiCN	Ti CN	+		10:4
	Innermost	Layer		Crystel Struc-	Granuler			Granular	Granular			- James la L	Cranular			Gramiar	Grams lar	Granular	Granular	+	Granuler	_
	Ig	3		Compo- sition	rin.			7in (0.5)	TiN (0.5)		ric.		TiN (1.6)	+	1		7 iv. 0	Tin (0.6)	TiN (0.8)	┪	-+	
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	Type	<u></u>			66	100		101	102		Ц		Invention 105	L		ļ	\sqcup					

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	Flank Wear	(mm)	Deep-cut Cutting	0.15	0.20		0.19		0.19	0.22	0.17	;	97.0	0.21	0.20	0.23	0.17		0.22	0.19	0.17
	Flan)	5 .	High-feed Cutting	0.15	0.16		0.17		0.21	0.16	0.15	5	3	0.20	0.24	0.19	0.15	: :	0.15	0.16	0.16
		Outermost Layer	Crystel Struc-	ture	Cranular	N. anular	Granular		Granular		Gramita			Granular			abinua di di				Granuler
		Ont 1	Compo- sition	TIN	(0.2)	(0.2)	TICN-	(0.6)	(0.2)		Tin	(0.2)		TiN (0.2)		Tin	-	+			Tin
		Outer Layer	Crystal Structure	K:948	K: 1008		K: 100\$	2	K: 7.3%	K: 1008	K: 734	K: 558		K:85%	K: 62%	K: 948	K:738		\$ 70 : v	x: 100%	K: 738
Laver		Outei	Compo- sition	A1203	(2.5) A120 ₃	(2.7)	(2.0)	A1503	(2.7)	A1203	A1203	(1.9) A1203	13.3	A1203	A1203	A1203	41203	(5, 2) A1,203	(8.1)	A1203	A1203
Hard Coating Layer		Second Intermediate Layer	Crystel Struc-	Granular	Granular					Granular	Granular		a la	Granular	Granular		Granular				
Hard		Se Inter	Compo- sition	TiCNO	TICNO					7iC0	TiCNO	Tico	G 5		TiCNO (0.1)		TICNO	 -			-
		First Intermediate Layer	Crystal Struc-		Granular		Granular		Granular		Granular				Granular				or amutar	-	Granular
			Compo- sition		7ic (3.0)	Tic	(1.9)	Tic	(3.0)		Tic (3.8)				7ir (1.8)			7 i CN	-+-		Tic (1.2)
		Inner Layer	Orientation	1002) (022) (111)	(220) (111) (200)		(007) (777) (111)	(111) (200) (220)	1000	(111) (220) (200)	(1111) (200) (220)	(111) (220) (200)		(220) (111) (200)	(220) (200) (111)	(111) (220) (200)	(111) (220) (200)	1002111111022	+	(111) (220) (200)	(111) (220) (200)
	Sub-	Symbol		¥	4	<		4	_	,	E	6	U	1		U	ء	0	-	_	٥
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TABLE 19 (a)

			Forth Divided Layer	Crystel	Structure	Elongeted	Greeth												Grant.	٠.				
			Forth	Compo	altion Figure	(2.5)						_		1	+		+	- -	ē.		-	+	-	
			Third Dividing	Crystal	Struc. ture										1							\dagger	+	
			Third	Ç de C				\top			-	1	_	\dagger	\dagger		-		(2.5)	_		+	+	
		İ	Third Divided Layer	Crystal	• cructure				Growth		Flongetod	C Concre		Elongeted	Growth			Slongeted					+	
			Third D	Compo				TiCN	1.9		11.01	1		Tics				TiCN	-			\vdash	+	
iyer	Inner Layer		Second Dividing Layer	Crystal	ture			Granular			Granular	1		Granular				Granular	\dagger					
Hard Coating Layer	Ę		Second	Compo-				Tin	(6.0)		Tin (0.1)			Tin				Tin		1	•		\dagger	
Hard Co		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	layer	Crystal Structure	El anges	Growth	Elongated	Elongated	Growth	Elongated	Elongated Growth		Elongated Growth	Elongeted	Flordet ad	Growth	Elongated	Blongated	Elongared	Growth	Elongated Growth	Elongated	Growth	Growth
				Compo- sition	Tich	?	11.0	TICN	i i	(2.3)	TiCN (1.1)	TiCN	(3.3)	71CN (0.8)	TICN	6	(2.0)	TiCN (0.6)	T, C.	201	_	7.C.	╫	(1.6)
		First Dividing	Pyer.	Crystal Struc-	Granular		Granular	Granular		Granuler	Granuler		Granutar	Granular	Gramuler		Granuler	Granular	Granular		Granular	Granular	Granular	
		L	_	Compo-	Tin		(0.1)	TIN (0.2)	Tin	(0.3)	71N (0.2)	Tin	10.21	7in (0.1)	Nit o	-		TiN (0.2)	Nit 0	-	_		+	(10.2)
		First Davided Layer		Crystal Structure	Elongated	Growth	Elongated Growth	Elongated		Greeth	Elongat ed Grouth	1	Growth	Elongated	Slongated	Growth	Elongated Growth	Elongated Growth	Elongated	Growth	Elongated Growth	Elongated	-	
		First		Compo- nition	TiCN	TiCN	(0.9)	1iCN	Tick	(2.2)	N T	TiCN	6.6	(1.1)	TiCN	Ti CN	(2.2)	TiCN (0.7)	TiCN	+-	-+		S 2	4
	inermost Layer	L		Crystal Struc-	Cranuler		Granular				Granular			Granular				Granular	Granular				Granular	
	<u> </u>			Compo- aition	7 in	TiN-	71CN				. Nir. (0.9)		į	(0.5)					N C . 0	Nit	-+		Tic (0, 7)	
-dog	Symbol				ts.			۵.	Ŀ		,	9	,	,	ن	Jo		ш	w	_	1	, , ,	ù	1
ı	1ype				CI .	114	_]	SII.	116]=		Cutting 118	1	Invention	971	121				ž	Ē		971	-
<u></u> -										.		55	100 110	, La					-	_				

	Flank Wear	(العلم)	Interrupted Cutting	0.18	0.19	0.25	0.21	0.20	0.24	0.20	0.19	0.23	(Milling)	(Milling)	(Milling)	(Milling)	illingl
	Flan	<u> </u>	Continuous Cutting	0.14	0.12	0.13	0.14	0.12	0.11	0.15	0.14	0.12	0.14 (M	0.15 (M	0.14 (M	0.15 (M	0.14 (Milling)
		Outermost Layer	Crystal Struc-	Granular	Granular		Granular		Granular	Granuler			Granular		Granular		Granular
		Out	Compo- sition	TiN (0.2)	TiN (0.2)		TiN (0.3)		TiN (0.4)	TiN (0,5)			TiN (0.3)		TiN (0.2)		Tin (0.2)
		Outer Layer	Crystal Structure	K: 1008	K: 948	K: 1008	K:948	K:558	K:948	к: 62%	K:858	K:1008	K: 948	K: 1008	K: 1008	K: 1008	K: 94%
Layer		Outer	Compo- sition	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203
Hard Coating Layer		Second Intermediate Layer	Crystal Struc-	Granular	Granular			Granular	Granular		Granular			Granular	Granular		Granular
Hard		Se Inte	Compo- sition	TiCO (0.1)	TiCNO (0.2)			TiCO (0.1)	TiCO (0.1)		TiCNO (0.1)			TicNO (0.1)	TiCNO (0.1)		TiCNO (0.2)
		First Intermédiate Layer	Crystal Struc- ture	Granular		Granular				Granular	Granular			Granular		Granular	
		F Inte	Compo- sition	TiCN (1.4)		4.CN				TiN (1.1)	TiC (2.9)			TiC (1.4)		TiCN (0.8)	
		Inner Layer	Orlentation	(220) (111) (200)	(111) (220) (200)	(111) (220) (200)	(111) (200) (220)	(111) (220) (200)	(220) (1111) (200)	(220) (200) (111)	(111) (220) (200)	(220) (1111) (200)	(111) (220) (200)	(220) (1111) (200)	(111) (220) (200)	(220) (111) (200)	(1111) (220) (200)
	Sub-	Symbol		li.	Ĺ.,	í.	<u>:-</u>	U	U	ט	U	U	ы	ы	Э	ü	ພ
		cu .			ž	115	116	117	8: 7	119	120	121	122	133	124	125	126
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	Plank Wear (mm)			O.53 (Chipping)	0.52	0.43	Builden	(Chipping)	0.60 (Chipping)	0.39 (Chipping)	Failure efter	to Layer	Feilure atter 20.8 min. due	to Layer Separation	Feilure ofter 9.8 min. due	Separacion	20.6 min. Jue	Separation	0.5¢ (Chipping)	failue after	to frecturing	5.9 min. due to Fracturing	Failure ofter
				(Chipping)	0.61 (Chipping)	0.59	9	(Chipping)	0.64 (Chipping)	0.59 (Chipping)	Failure after	to Layer	Failure after 19.5 min. due	Separation	Failure after 15.1 min. due	Separation Failure after	19.5 min. due to Layer	Seperation	(Chipping)	Failure after	+	_	Failure after
	Outermost Layer		ture	Granular	Gramuler	Granuler		Granular		Granular			Gramular				Granular	T					Gramular
	3	9	6 2	(0.2)	TiN (0.2)	TICN	0.0 1.0 1.0	ê		1 LS			TiN (0.2)			Tin	(0.5)	1			†		zi.
	Outer Layer	Crystel			a:1001	K: 401	g:100#		a:1001	α:1001	u: 1008		a:1001		K: 40	4001		3001		α: 100¢	a: 1004	-	α:1001
	Onte	Compo	170	7.7.	A1203	A1203	A1203	13.51	A1203	A1203	A1203	(3.2)	A1203	3	6.9	A1203	(2.5)	A1203			A1203	_	A1203
	Second	Crystell Strong	ture	Grenuler	Granuler				Granuler	Granuler	Gramler		Gramular	1	Gzanular	T		┿-	Gramiler			7	<u> </u>
ie.	Se	Compo-	TICNO	(0.1)	TiCNO (0.1)	-	T	Ę.		TiCNO (0.1)	TiC0		11.01	Ticko		\dagger		+-	5 ?;		\dagger	\dagger	_
Hard Coating Layer	First Intermediate	Crystal Struc-	ture		Granular	Granular	Gramilar			Granular					Granuler			-		Granular	+-	- -	Granular
Hard Co	Inter	Compo- sition		i i	(2.8)	TiC (2.0)	Tic	5	1	(3.6)		1		rin	8.1)	\vdash		 	1	1.2	+	12	_
	Inner Layer	Orlentation	(111) (2001 (220)		(220) (200) (1111	(111) (200) (220)	(200) (220) (111)		(111) (200) (220)	(220) (200) (1111)	(200) (220) (111)		(111) (2001 (2201	+-	(1111) (207) (277)	(111) (200) (220)		(220) (200) (111)	+	(011) (300) (320)	(220) (200) (111)	+	(111) (200) (220)
	Inner	Crystal Struc-	Granular		Gramular	Granular	Granular		Cranular	Granular	Gramular	1	Granular			Granular		Gramler	\dagger	Granular (Cramler		Granuler (
		Compo- sition	TiCN	TICN	(6.1)	(6.3)	TiCN	N.	€ .4 1,Cv	(6.6)	TiCN (F. 7)	NO.	(9.8)	+	(2.5)	TiCN 17.73		N C	NO.	_	TiCN (8.2)	+	(6.9)
	Innermost Layer	Crystal Struc-	Granular			Granuler	Gramular			Granular	Granuler			Granular		Granuler		Granular	+-	Granular	Gramiler	-	_
	Inl	Compo- sition	rir S G		T.N.	(0.6)	TiN (0.5)		Tic.	Tin (1.5)		1		Tic		(S. 5)		- (9.0)	-		TiCN (0.5)	\dagger	\exists
á	Symbol		4	<	_		4				8	ľ		J		u	+	 a	٥		Δ	_	\dashv
			66	8	101		707	<u>5</u>	ž		So.	106		101	-		80	_	8	\dashv	=	3	\dashv
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5		Plank Wear	(mm)	Interruped	+	Feilure after 7.6 min. due to Fracturing	Feilure after 3.1 min. due to Frecturing	Feilure after 6.3 min. due to Frectuzing	Failure after 5.8 ain. due to Fracturing	Failure after 4.5 min. due to Fracturing	Failure after 7.4 win. due	Tailure after 7.9 min. due to Frecuring	Failure after 5.2 min. due to Frecturing	(Chipping)	(Chipping)	(Chipping)	(Chipping)	pping)
10		Flan		Cont snuous Cut cing	Failure after 13.6 min. due	Failure after 16.0 min. due to Chipping	Failure after 14.4 min. due to Layer	Failure efter 15.1 min. due to Layer	Separation Failure atter 17.4 min. due to Chipping	Fellure after 16.2 min. due to Leyer	Separation Fellure after 12.5 min. due	Failure after 13.3 min. due to Layer	Failure after 17.6 min. due to Layer	. 3	0.37 (Chipp	0.33 (Chippi	0.38 (Chippi	0.36 (Chipping)
			Outermost Layer	Crystal Struc-	┼─	Grenular		Granular		Gramuler	Gramler			Granuler		Granuler		Gramler
15			8	Compo- sition	TiN (0.2)	TÍN (0.2)		TiN (0.3)		Tin (0.4)	TiN (0.5)			NIT O		TIN (2.0)		Tiv
			Outer Layer	Crystal Struc-		α:1001	K: 401	a: 1001	a:1001	a:1001	K: 401	α:1001	K: 401	a:1001	α:100 1	a: 1001	α: 1001	a: 1001
20			Ouce	Compo- eltion	A1203	A1203	A1203 (1.5)	A1203	A1203	A1203	A1203	A1203	A1203	A1203	A1203	14 203	A1203	+-
			Second Intermediate Layer	Crystal Struc- ture	Granular	Granular			Granular	Granular		Granular			Granuler	Granuler		Granular
25		e.	Inte	Compo- sition	7iC0	TiCNO (0.2)			Tico (0.1)	TiCO (0.1)		TiCNO (0.1)			TiCNO (0.1)	TiCNO (0.1)		TiCNO (0.2)
	TABLE 21	Hard Coating Layer	Pirst Intermediate Layer	Crystal Struc- ture	Grenular		Granular				Granuler	Granular			Granular		Granular	
30	Ţ	Hard Co	Intex	Compo- sition	T1CN (1.5)		TiCN (1.2)				Tin (1.8)	Tic (2.8)			ric (1.5)		TiCN (0.9)	
35			Løyer	Orientation	(111) (200) (220)	(220) (200) (111)	(131) (200) (111)	(200) (320) (111)	(111) (200) (220)	(111) (200) (111)	(200) (220) (111)	(111) (200) (111)	(220) (2001 (311)	(111) (200) (220)	(220) (200) (111)	(111) (200) (220)	(111) (300) (111)	(111) (200) (220)
·			Inner Løyer	Crystel Struc- ture	Gramuler	Grenular	Granuler	Gramlar	Granuler	Granular	Granuler	Granular	Granular	Granular	Granular	Granular	Granular	Scanuler
40				Compo- sition	71CN (3.2)	TiCN (2.1)	TiCN (6.5)	TiCN (4.6)	Tick (3.5)	TiCN (7.0)	TiCN (3.1)	Ticn (3.3)	TiCN (4.5)	TiCN (3.2)	TiCN (2.6)	TiCN (3.5)	TICN (3.0)	TiCN (2.9)
			Innermost Layer	Crystel Struc- ture	Granular	Granular			Granular		Granular			Granular	Granuler	Granutar		Granular
45				Compo- sition	(0.3)	TiCN (0.9)	,		TiC- TiN (1.0)		TiN (0.6)			TiCN (0.51	7 in (0.0)	Tin (0.3)		7.ic (0.81
		- Sep-	Symbol			ta.	۵.	Cu.	U	၁	Ü	υ	v	ı,	ω	'n	ù	ώ
			•		2		=	ž	117	8 11	£	120	<u> </u>	<u> </u>	<u> </u>	<u>.</u>	£ 1	126
50		-	Турв							Conted Cemented Carbide Cutting	Prior Art							

Claims

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- 1. A coated hard alloy blade member comprising a substrate formed of a hard alloy selected from the group consisting of a WC-based cemented carbide and a TiCN-based cermet, and a hard coating deposited on said substrate, said hard coating including an inner layer of TiCN having unilaterally grown crystals of an elongated shape obtainable by a two-step deposition process wherein a first coating of TiCN is formed using a CVD gas for TiCN deposition comprising acetonitrile having a concentration of acetonitrile gas from 0.01 to 0.1 vol % and a second coating of tonitrile is increased to be from 0.1 to 1.0 vol % and an outer layer of Al203 having a crystal form of κ or κ + α, wherein, κ > a.
 - A coated hard alloy blade member according to claim 1, wherein the substrate is formed of a WC-based cemented carbide substrate.
- 3. A coated hard alloy blade member according to claim 1 and/or 2, wherein the TiCN in said elongated crystals of said inner layer has X-ray diffraction peaks such that strength (200) plane is weak compared to strengths at (111) and (220) planes.
- 4. A coated hard alloy blade member according to any one of the preceding claims wherein said hard coating further includes an innermost layer of one or more of granular TiN, TiC, or TiCN formed underneath said inner layer.
 - A coated hard alloy blade member according to any one of the preceding claims, wherein said hard coating further includes an outermost layer of one or both of granular TiN or TiCN formed on said outer layer of Al₂O₃.
- 6. A coated hard alloy blade member according to any one of the preceding claims, wherein said hard coating further includes a first intermediate layer of one or more of granular TiC, TiN, or TiCN formed between said inner layer of TiCN and said outer layer of Al₂O₃.
- A coated hard alloy blade member according to any one of the preceding claims, wherein said hard coating further includes a second intermediate layer of one or both of TiCO or TiCNO formed between said inner layer of TiCN and said outer layer of Al₂O₃.
 - A coated hard alloy blade member according to any one of the preceding claims, wherein said inner layer of TiCN further includes one or more layers of TiN such that the inner layer is divided by the layers of TiN.
 - 9. A coated hard alloy blade member according to any one of the preceding claims, wherein said WC-based cemented carbide consists essentially of 4 12 % by weight of Co, 0 7 % by weight of Ti, 0 7 % by weight of Ta, 0 4 % by weight of Nb, 0 2 % by weight of Cr, 0 1 % by weight of N, and balance W and C.
- 40 10. A coated hard alloy blade member according to claim 8, wherein the maximum amount of Co in a surface layer of the substrate ranging up to 100 μm depth from a surface thereof is 1.5 to 5 times as much as the amount of Co in an interior 1 mm deep from the surface.
- 11. A coated hard alloy blade member according to any one of the preceding claims, wherein said TiCN-based cermet consists essentially of 2 14 % by weight of Co, 2 12 % by weight of Ni, 2 20 % by weight of Ta, 0.1 10 % by weight of Nb, 5 30 % by weight of W, 5 20 % by weight of Mo, 2 8 % by weight of N, optionally no greater than 5 % by weight of at least one of Cr, V, Zr or Hf, and balance Ti and C.
- 12. A coated hard alloy blade member according to claim 11, wherein hardness in a surface layer of the substrate ranging up to 100 μm depth from a surface thereof is more than 5% harder than hardness of an interior 1 mm deep from the surface
 - 13. The use of a hard coated blade member according to any one of the preceding claims in cutting tools.

55 Patentansprüche

1. Beschichtetes Hartlegierungs-Klingenelement, umfassend:

ein Substrat aus einer harten Legierung, ausgewählt aus auf WC basierendem Sinterkarbid und einem auf TiCN basierendem Cermet,

und eine harte Beschichtung abgeschieden auf dem Substrat, die harte Beschichtung schließt eine innere Schicht aus TiCN ein, die unilateral gewachsene Kristalle mit gestreckter Form aufweist, erhältlich durch ein zweistufiges Abscheidungsverfahren, worin eine erste TiCN-Beschichtung durch Verwenden eines Acetonitril umfassenden CVD-Gases für die TiCN-Abscheidung gebildet wird, das Acetonitrilgas in einer Konzentration von 0,01 bis 0,1 Vol.% besitzt, und eine zweite Beschichtung aus TiCN durch Verwenden eines Acetonitril umfassenden CVD-Gases für die TiCN-Abscheidung, worin die Konzentration von Acetonitril auf 0,1 bis 1,0

eine äußere Schicht aus Al_2O_3 , die eine Kristallform von κ oder κ + α aufweist, worin κ > α ist.

- Beschichtetes Hartlegierungs-Klingenelement nach Anspruch 1, worin das Substrat aus einem auf WC basieren den Sinterkarbidsubstrat gebildet wird.
 - Beschichtetes Hartlegierungs-Klingenelement nach Anspruch 1 und/oder 2, worin das TICN in den gestreckten Kristallen der inneren Schicht Röntgen-Diffraktionspeaks aufweist, deren Intensität für die (200) Ebene schwach ist im Vergleich zur Intensität für die (111) und (220) Ebenen.

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- 4. Beschichtetes Hartlegierungs-Klingenelement nach mindestens einem der vorhergehenden Ansprüche, worin die harte Beschichtung weiterhin eine innerste Schicht, die aus k\u00f6rnigem TiN, TiC oder TiCN oder mehreren gebildet wird, unterhalb besagter inneren Schicht einschlie\u00dft.
- 25 5. Beschichtetes Hartlegierungs-Klingenelement nach mindestens einem der vorhergehenden Ansprüche, worin die harte Beschichtung weiterhin eine äußerste Schicht, gebildet aus k\u00f6rnigem TiN oder TiCN oder beidem, auf der \u00e4useren Schicht von Al₂O₃ einschlie\u00dst.
- Beschichtetes Hartlegierungs-Klingenelement nach mindestens einem der vorhergehenden Ansprüche, worin die harte Beschichtung weiterhin eine erste Zwischenschicht aus körnigem TiC, TiN oder TiCN oder mehreren davon zwischen der inneren Schicht aus TiCN und der äußeren Al₂O₃-Schicht einschließt.
 - 7. Beschichtetes Hartlegierungs-Klingenelement nach mindestens einem der vorhergehenden Ansprüche, worin die harte Beschichtung weiterhin eine zweite Zwischenschicht aus TiCO oder TiCNO oder beiden zwischen der inneren Schicht aus TiCN und der äußeren Al₂O₃-Schicht einschließt.
 - Beschichtetes Hartlegierungs-Klingenelement nach mindestens einem der vorhergehenden Ansprüche, worin die innere Schicht aus TiCN weiterhin eine oder mehrere Schichten aus TiN einschließt, so daß die innere Schicht durch die TiN-Schichten geteilt ist.
 - Beschichtetes Hartlegierungs-Klingenelement nach mindestens einem der vorhergehenden Ansprüche, worin das auf WC basierende Sinterkarbid im wesentlichen aus 4 - 12 Gew.% ·Co, 0 - 7 Gew.% Ti, 0 - 7 Gew.% Ta, 0 - 4 Gew.% Nb, 0 - 2 Gew.% Cr, 0 - 1 Gew.% N und zum Rest aus W und C besteht.
- 45 10. Beschichtetes Hartlegierungs-Klingenelement nach Anspruch 8, worin die Höchstmenge an Co in der Oberflächenschicht des Substrats in einer Tiefe von bis zu 100 μm von der Oberfläche 1,5 bis 5-mal so groß ist wie die Menge an Co in einer inneren Schicht in einer Tiefe von 1 mm von der Oberfläche.
- 11. Beschichtetes Hartlegierungs-Klingenelement nach mindestens einem der vorhergehenden Ansprüche, worin das auf TiCN basierende Cermet im wesentlichen aus 2 14 Gew.% Co, 2 12 Gew.% Ni, 2 20 Gew.% Ta, 0,1 10 Gew.% Nb, 5 30 Gew.% W, 5 20 Gew.% Mo, 2 8 Gew.% N, optional nicht mehr als 5 Gew.% wenigstens eines der Elemente Cr, V, Zr oder Hf und zum Rest aus Ti und C besteht.
- 12. Beschichtetes Hartlegierungs-Klingenelement nach Anspruch 11, worin die Härte der Oberflächenschicht des Substrats bis zu einer Tiefe von 100 μm von der Oberfläche um mehr als 5 % härter ist als die Härte einer inneren Schicht in einer Tiefe von 1 mm von der Oberfläche.
 - 13. Verwendung eines hart-beschichteten Klingenelements nach mindestens einem der vorhergehenden Ansprüche in

Schneidewerkzeugen.

Revendications

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- Elément de lame en alliage dur à revêtement comprenant un substrat formé en un alliage dur choisi dans le groupe constitué par un carbure fritté à base de WC et par un cermet à base de TiCN, et un revêtement dur déposé sur gée formés unilatéralement, cette couche étant subsceptible d'être obtenue par un procédé de revêtement en deux prenant de l'acétonitrile ayant une concentration en gaz acétonitrile dans la plage de 0,01 à 0,1 % en volume et un dans lequel la concentration en acétonitrile est augmentée pour se situer dans la plage allant de 0,1 à 1,0 % en volume et une couche externe d'Al₂O₃ ayant la forme cristalline κ ου κ + α, οὺ κ > α.
- Elément de lame en alliage dur portant un revêtement selon la revendication 1, dans lequel le substrat est formé par un substrat de carbure fritté à base de WC.
 - 3. Elément de lame en alliage dur portant un revêtement selon la revendication 1 et / ou 2, dans lequel le TiCN dans lesdits cristaux allongés de ladite couche interne a des pics de diffraction des rayons X, où la composante correspondant au plan (200) est faible par comparaison avec la composante correspondant aux plans (111) et (220).
 - 4. Elément de lame en alliage dur portant un revêtement selon l'une quelconque des revendications précédentes, dans lequel ledit revêtement dur comprend en outre une couche interne profonde en un ou plusieurs composés granulaires TiN, TiC ou TiCN, formée sous le couche interne.
 - Elément de lame en alliage dur portant un revêtement selon l'une quelconque des revendications précédentes, dans lequel ledit revêtement dur comprend en outre une couche externe de surface en TiN et /ou en TiCN granulaires formée sur ladite couche externe d'Al₂O₃.
- 6. Elément de lame en alliage dur portant un revêtement selon l'une quelconque des revendications précédentes, dans lequel ledit revêtement dur comprend en outre une première couche intermédiaire d'un ou de plusieurs composés TIC, TIN ou TiCN granulaires, formée entre ladite couche interne de TiCN et ladite couche externe d'Al₂O₃.
- Elément de lame en alliage dur portant un revêtement selon l'une quelconque des revendications précédentes, dans lequel ledit revêtement dur comprend en outre une seconde couche intermédiaire de TiCO et/ou de TiCNO, formée entre ladite couche interne de TiCN et ladite couche externe d'Al₂O₃.
- 8. Elément de lame en alliage dur portant un revêtement selon l'une quelconque des revendications précédentes, dans lequel ladite couche interne de TiCN comprend en outre une ou plusieurs couches de TiN, de sorte que la couche interne est divisée par les couches de TiN.
 - 9. Elément de lame en alliage dur portant un revêtement selon l'une quelconque des revendications précédentes, dans lequel le carbure fritté à base de WC est constitué essentiellement par 4 12 % en poids de Co, 0 7 % en poids de Ti, 0 7 % en poids de Ta, 0 4 % en poids de Nb, 0 2 % en poids de Cr, 0 1 % en poids de N, le reste étant W et C
 - 10. Elément de lame en alliage dur portant un revêtement selon la revendication 8, dans lequel la quantité maximale de Co dans une couche de surface du substrat allant jusqu'à 100 μm de profondeur depuis une surface de celui-ci est de 1,5 à 5 fois plus importante que la quantité de Co à l'intérieur, à 1 mm de profondeur, de la surface.
 - 11. Elément de lame en alliage dur portant un revêtement selon l'une quelconque des revendications précédentes, dans lequel le cermet à base de TiCN est constitué essentiellement par 2 14 % en poids de Co, 2 12 % en poids de Ni, 2 20 % en poids de Ta, 0,1 10 % en poids de Nb, 5 30 % en poids de W, 5 20 % en poids de Mo, 2 8 % en poids de N, le cas échéant pas plus de 5 % en poids d'au moins un des éléments Cr, V, Zr ou Hf, le reste
 - 12. Elément de lame en alliage dur portant un revêtement selon la revendication 11, dans lequel la dureté dans une couche de surface du substrat allant jusqu'à 100 μm de profondeur depuis une surface de celui-ci est supérieure

par 5 % à la dureté à l'intérieur, à 1 mm de profondeur, depuis la surface.

5	13.	Utilisation d'un élément de lame en alliage dur portant un revêtement selon l'une quelconque des revendications précédentes pour un outil de coupe.
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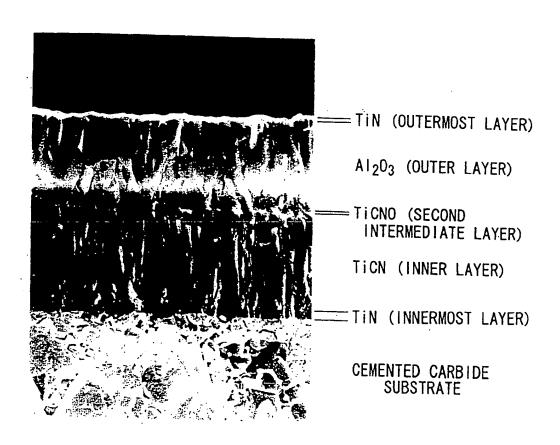


FIG. 1 COATED CEMENTED CARBIDE CUTTING TOOL "64"